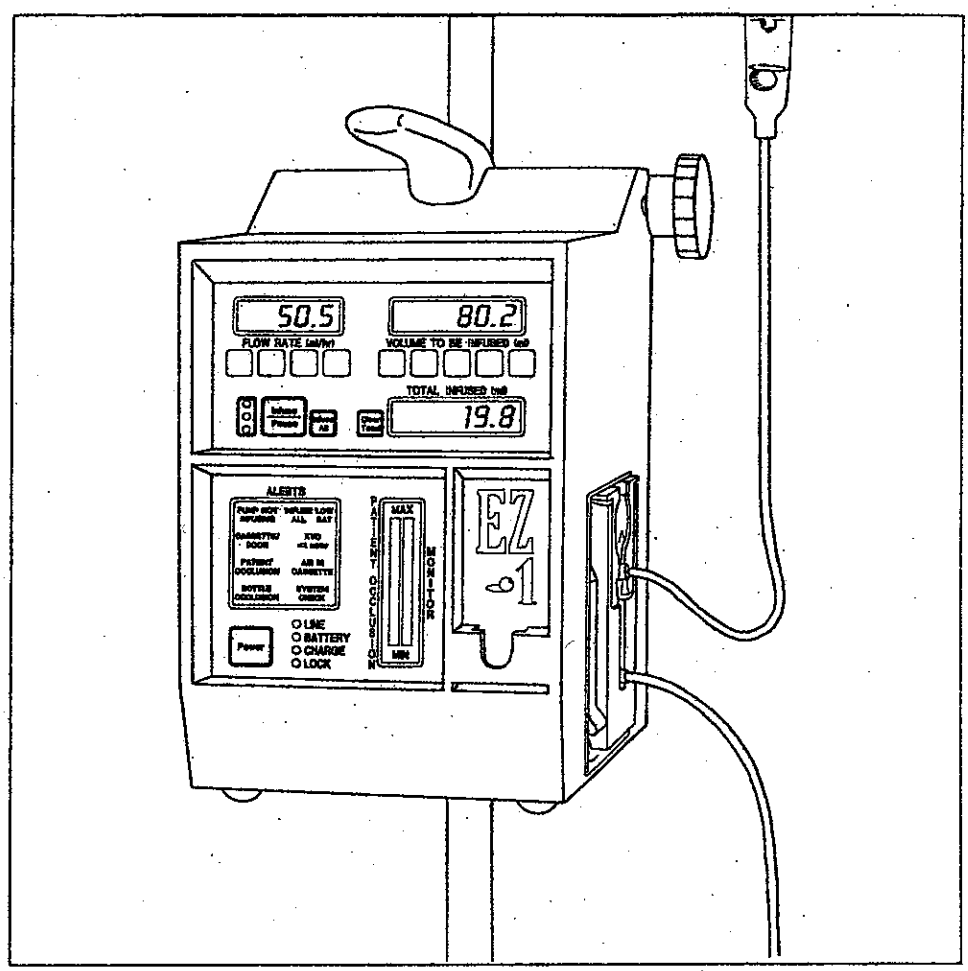
EZ-1 ™

Volumetric Infusion Pump

SERVICE MANUAL



INTENDED USE: The servicing instructions contained in this publication are for use by qualified personnel only.

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Warnings and Precautions

◆ ***Warnings:***

DANGER: Do not use in the presence of flammable anesthetics. The EZ-1 Pump presents a possible explosion hazard if used in the presence of flammable anesthetics.

▼ ***Precautions:***

- The intravenous (I.V.) administration set acts as a gravity-flow set when it is outside the pump or when the guide plate in the pump cassette door is pushed back. Always close the patient-side clamp on the I.V. set before opening the pump cassette door. Whenever loading the cassette into the pump, follow the instructions given in Chapter 7 of the EZ-1 Pump *Operation Manual.*
- A fraction of a milliliter of fluid is expelled into the patient-side line each time the pump cassette door is closed. To avoid this situation, disconnect the I.V. line from the patient prior to closing the pump cassette door, or follow the instructions given in Chapter 7 of the EZ-1 Pump *Operation Manual.*
- Hazardous voltages are present inside the pump. Do not remove the pump rear panel. Service requiring removal of the pump rear panel should be performed only by qualified personnel.
- This electronic device is equipped with a hospital-grade plug. Grounding reliability can only be achieved when the equipment is connected to an equivalent receptacle marked "Hospital Grade".
- Sterilizing by gas or steam autoclaving will damage the pump.

▼ ***Caution:***

Federal (USA) law restricts this device to sale by, or on the order of, a physician.

● ***Important:*** All service should be performed at a static-free work station.

● ***Important:*** ***Do not substitute parts or modify the instrument.*** Because of the danger of introducing hazards, do not install substitute parts or perform any unauthorized modification to the instrument. When in doubt, return the pump to an Ivion Authorized Representative or to Ivion Corporation's Service Department to ensure that all safety features are maintained.

● ***Certification:*** Ivion Corporation certifies that the EZ-1 Pump meets its published specifications at the time of shipment from the factory. All information contained in this *Service Manual*, including part numbers, is current as of the Effective Date shown on the front page, and is subject to change without notice.

■ ***Note:*** For full instructions to operate the EZ-1 Pump, refer to the EZ-1 Pump *Operation Manual.*

☎ ***To Contact Service Department:*** Should any questions arise or if return of defective components is indicated, please contact:

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How to Use This Manual

This *Service Manual* is organized in the following 8 sections:

- **Section 1: Pump Operating Information.** Contains a complete copy of the EZ-1 Pump *Operation Manual.* Use to refer to the pump operation instructions written for the health professional.
- **Section 2: Theory of Operation.** Explains the theory of the pump's operation.
- **Section 3: Maintenance Schedule.** Provides a recommended pump maintenance schedule.
- **Section 4: Troubleshooting.** Contains a troubleshooting chart to help diagnose pump problems.
- **Section 5: Part Replacement.** Gives part replacement procedures.
- **Section 6: Adjustment and Verification Procedures.** Gives pump adjustment and verification prodedures.
- **Section 7: Schematics and Assembly Diagrams.** Provides schematics and assembly diagrams for your reference.
- **Section 8: Parts Lists.** To help you re-order replacement parts.

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Section 2.0
Theory of Operation

2.1

Overview

The Ivion fluid delivery system is comprised of the EZ-1™ Infusion Pump and various disposable I.V. administration sets that are available in a number of configurations. The system is designed to provide qualified professionals with a practical and safe means of delivering intravenous or intra-arterial fluid while controlling both the rate of infusion and the volume to be infused. This system utilizes the Archimedes principle of fluid displacement to deliver a precisely controlled volume of fluid through the disposable administration set.

The mechanics of the fluid delivery system are contained in the EZ-1 Pump pumping module and in the disposable cassette. The diagram shown in Figure 1 depicts the major components of the pumping mechanism. All components in Figure 1, except the disposable cassette and tubing, are contained in the pumping module.

The administration sets are single-use disposables designed to isolate the fluid from contact with the pumping mechanism. The pumping mechanism acts on the fluid contained within the cassette portion of the administration set through a pair of elastomeric membranes.

The pump is controlled by two microprocessors (master and slave). In general terms, the master handles the inputs such as the input switches and the analog-to-digital converter, while the slave handles the outputs such as the display and the tone alarm.

The master communicates information concerning pump operation to the slave. The communication is accomplished such that either microprocessor can detect a failure of the other.

Both processors have independent means of checking the critical parameters of pump operation, pumping rate and delivery pressure. If an error is detected, either processor can stop the infusion.

The block diagram in Figure 2 shows the various electronic systems in the EZ-1 Pump.

Figure 1. Mechanical Pumping System Components

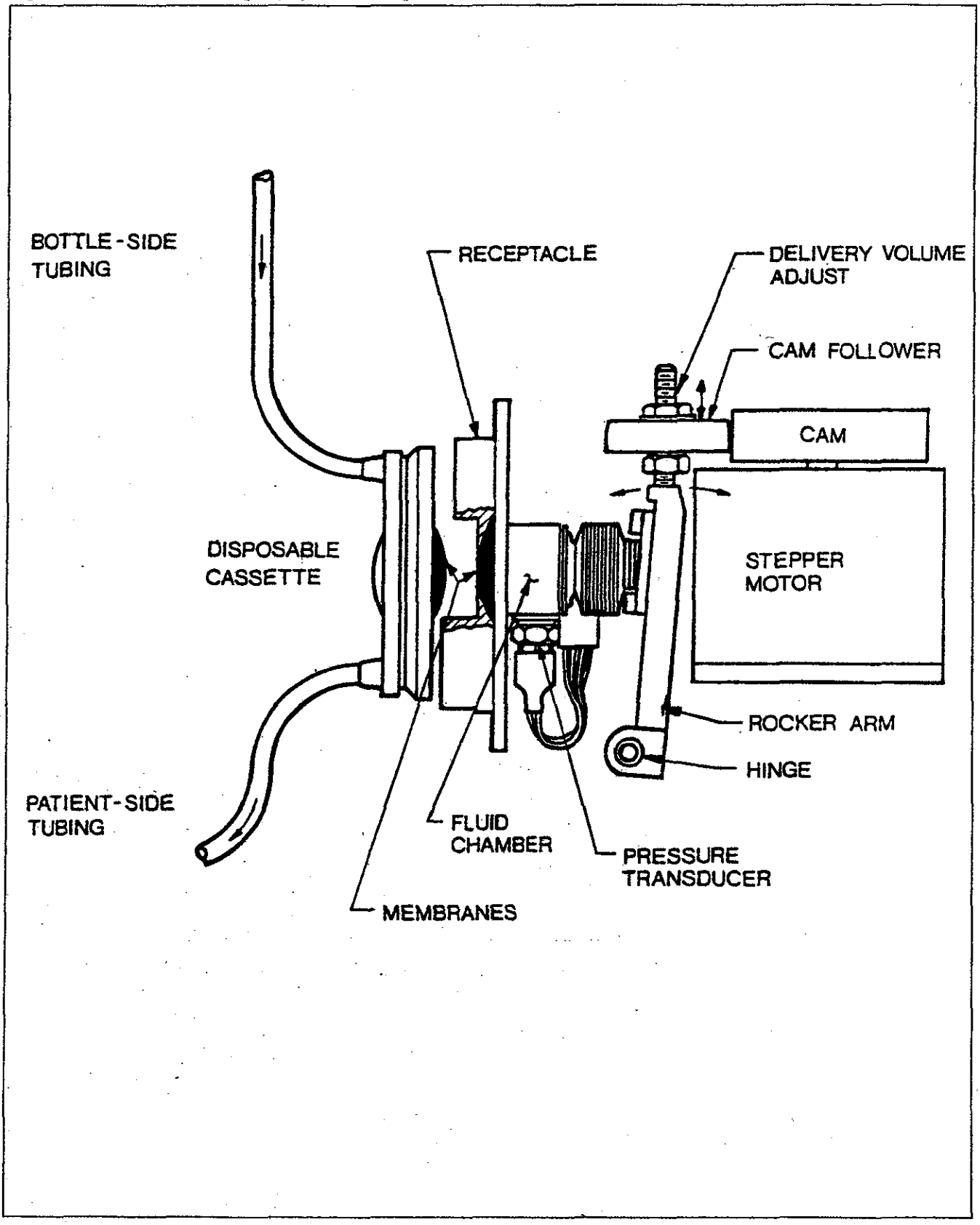
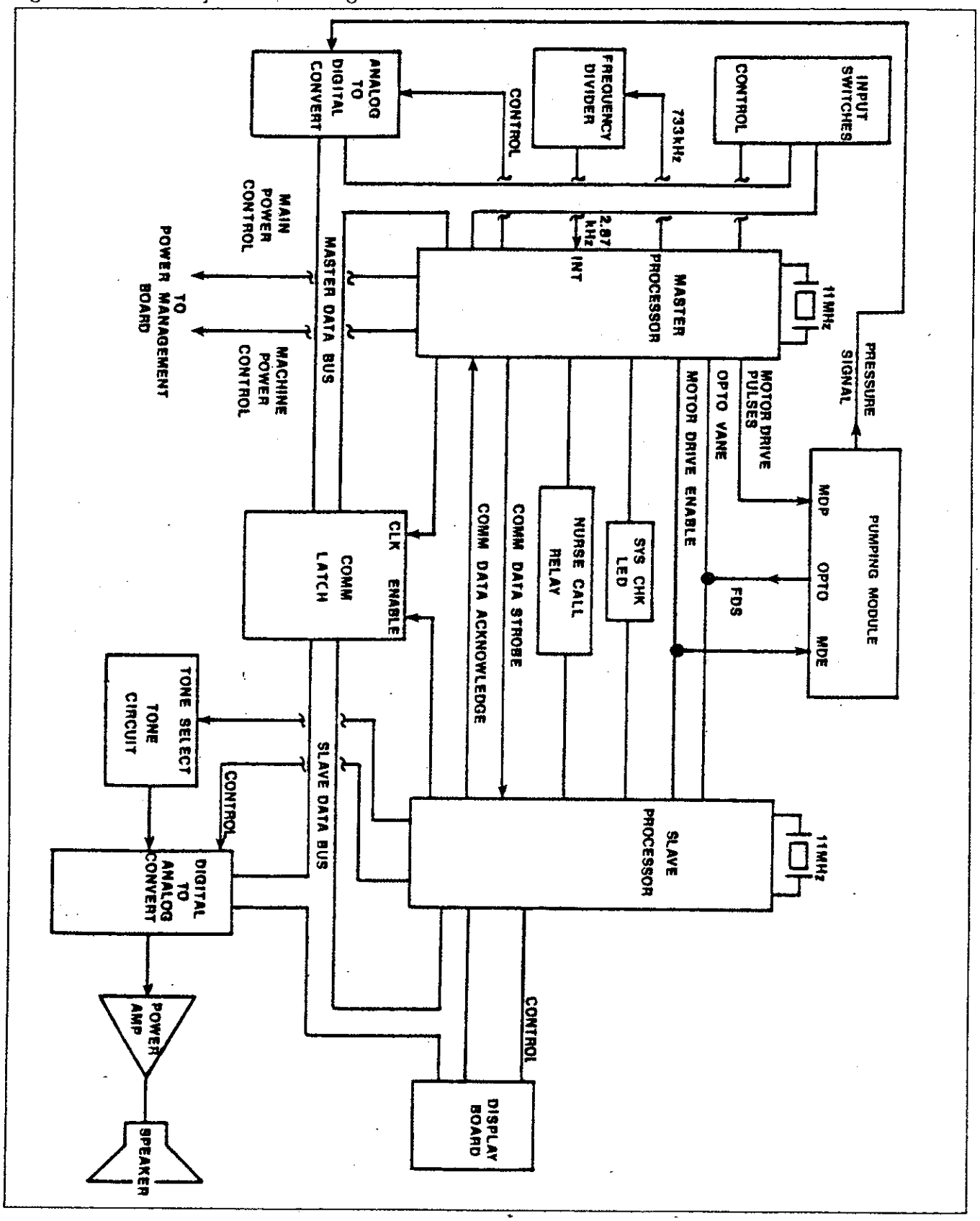


Figure 2. Electronic System Block Diagram



2.2

Refill/Delivery Cycle

Fluid is delivered to the patient using a two-part pumping cycle. The two parts are called refill and delivery. During refill, a chamber in the disposable cassette fills with fluid supplied from the bottle-side line.

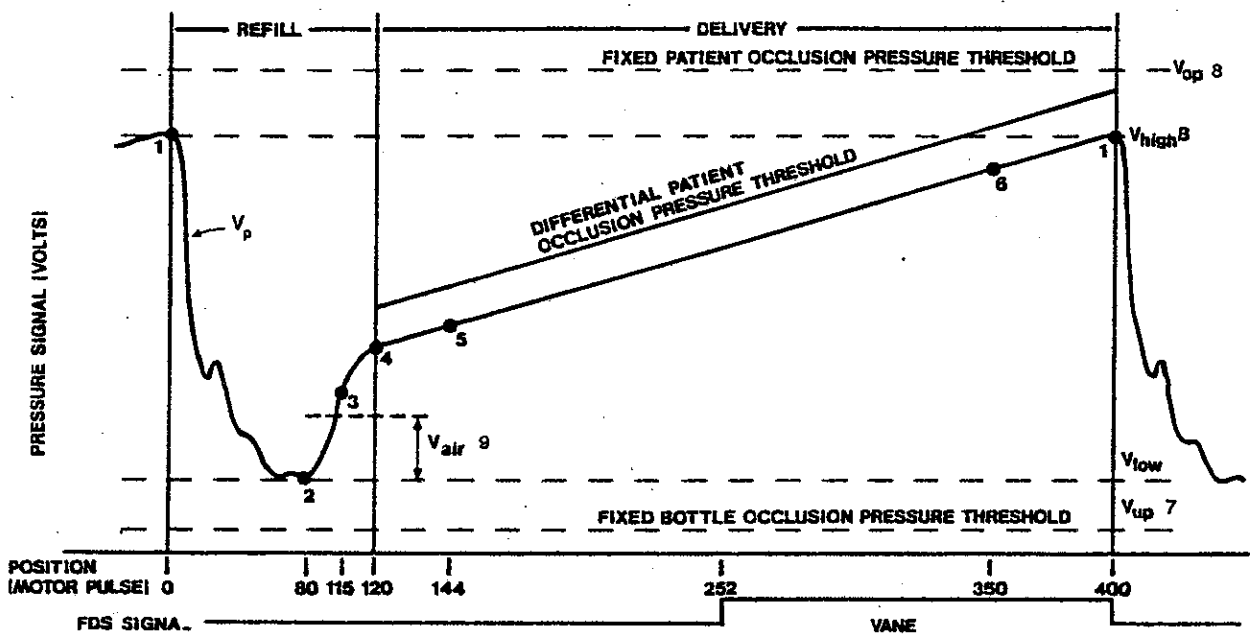
During delivery, a known volume of fluid discharges through the patient-side line. The delivery rate is controlled by altering the frequency of pulses to the stepper motor. Each complete pump cycle is a single motor revolution and requires 400 motor pulses. These pulses are delivered to the motor with a period of 2.44 milliseconds during refill. The period is altered during delivery to correspond to the programmed infusion rate.

The first 120 motor pulses occur during refill and the remaining 280 pulses occur during delivery. A vane attached to the motor shaft passes through an optical switch which generates the Cam Timing Signal (CTS) [also called Fill/Delivery Signal (FDS)].

The leading edge of the vane breaks the beam at mid-delivery, sending motor position information to the microprocessors. At the trailing edge of the vane the opto-beam is remade, generating the CTS signal by which the microprocessors verify motor position and causing another pumping cycle to start.

PATIENT OCCLUSION, BOTTLE OCCLUSION, and AIR IN CASSETTE are detected by indirectly sensing the pressure in the disposable cassette and monitoring the pressure in the receptacle. Figure 3 depicts a typical receptacle pressure vs. motor position graph. Alerts are triggered when the pressure signal crosses pressure thresholds. High delivery pressure indicates a PATIENT OCCLUSION and low pressure in the bottle-side line indicates a BOTTLE OCCLUSION. AIR IN CASSETTE is detected by monitoring the slope of the pressure curve. These threshold levels and pressure signal are shown in Figure 3.

Figure 3. Receptacle Pressure Signal vs. Motor Position



Events:

1. $V_{high}B$: Highest pressure reached during pumping cycle.
   End of delivery, beginning of refill (pulse 0)

2. V_{low}: lowest pressure reached (occurs approximately at pulse 70-90)

3. Air pressure detect point (pulse 115)

4. Beginning of delivery (distal valve opens, approximately pulse 120)

5. $V_{ref}L$: lower benchmark slope detection point (pulse 144)

6. $V_{ref}H$: higher benchmark slope detection point (pulse 350)

Thresholds:

7. V_{up}: the fixed BOTTLE OCCLUSION pressure threshold

8. V_{op}: the fixed PATIENT OCCLUSION pressure threshold

9. V_{air}: air detect offset voltage

2.3

Patient Occlusion Detection

(Refer to Figure 3.)

Two patient occlusion detection modes exist in the EZ-1 pump:

1. **Fixed patient occlusion pressure** - referred to as "fixed overpressure".

2. **Differential patient occlusion pressure** - referred to as "differential overpressure" or "auto overpressure".

If the pressure required for a delivery reaches either the fixed or differential limits, pumping will stop, and the PATIENT OCCLUSION and PUMP NOT INFUSING alerts will activate.

1. Fixed Overpressure

Fixed overpressure is an absolute maximum limit of pressure which can build up in the pumping mechanism, as monitored by a pressure transducer in the receptacle. Fixed overpressure calculations are performed by the master microprocessor. The current pressure is compared to a "fixed patient occlusion pressure threshold":

$V_p \geq V_{op}$ generates a PATIENT OCCLUSION alert.

2. Differential Overpressure

Differential overpressure sets a pressure limit based on the pressure required for an individual infusion. Using this method, the parameters which vary from infusion to infusion (such as flow rate, fluid type, needle size, temperature) are taken into account. Differential overpressure computations are performed by the slave microprocessor.

The "benchmark stroke" is used to account for these varying parameters. The benchmark stroke is defined as the first complete pump stroke executed after entering the infuse state. During the benchmark stroke, the following data are recorded (refer to Figure 3):

$V_{ref}L$ = pressure sample at point 5 on Figure 3 (pulse 144)

$V_{ref}H$ = pressure sample at point 6 on Figure 3 (pulse 350)

At the end of the benchmark stroke, the slope of the delivery pressure curve is calculated using these two reference points.

By using these data, and using a reference voltage set by the High/Low Pressure Limit switch on the rear panel of the pump, the differential overpressure trip level is set.

2.4

BOTTLE OCCLUSION Detection

The BOTTLE OCCLUSION alert occurs when the pressure signal is less than the fixed bottle occlusion pressure threshold (also referred to as "under-pressure").

$V_p < V_{up}$ indicates a BOTTLE OCCLUSION.

2.5

AIR IN CASSETTE Detection

An air detect alert is generated by comparing V_p to an offset voltage, V_{air}, relative to V_{low}. A low pressure signal at motor pulse 115 indicates air in the cassette. The algorithm is as follows:

$V_{p115} \leq (V_{low} + V_{air})$ generates an AIR IN CASSETTE alert.

2.6

Pump Module Mechanics

The pump module contains the mechanical components that drive the cassette to pump fluid (refer to Figure 4). The pump module is a discrete assembly in the EZ-1 Pump. Its modular design allows easy removal and replacement.

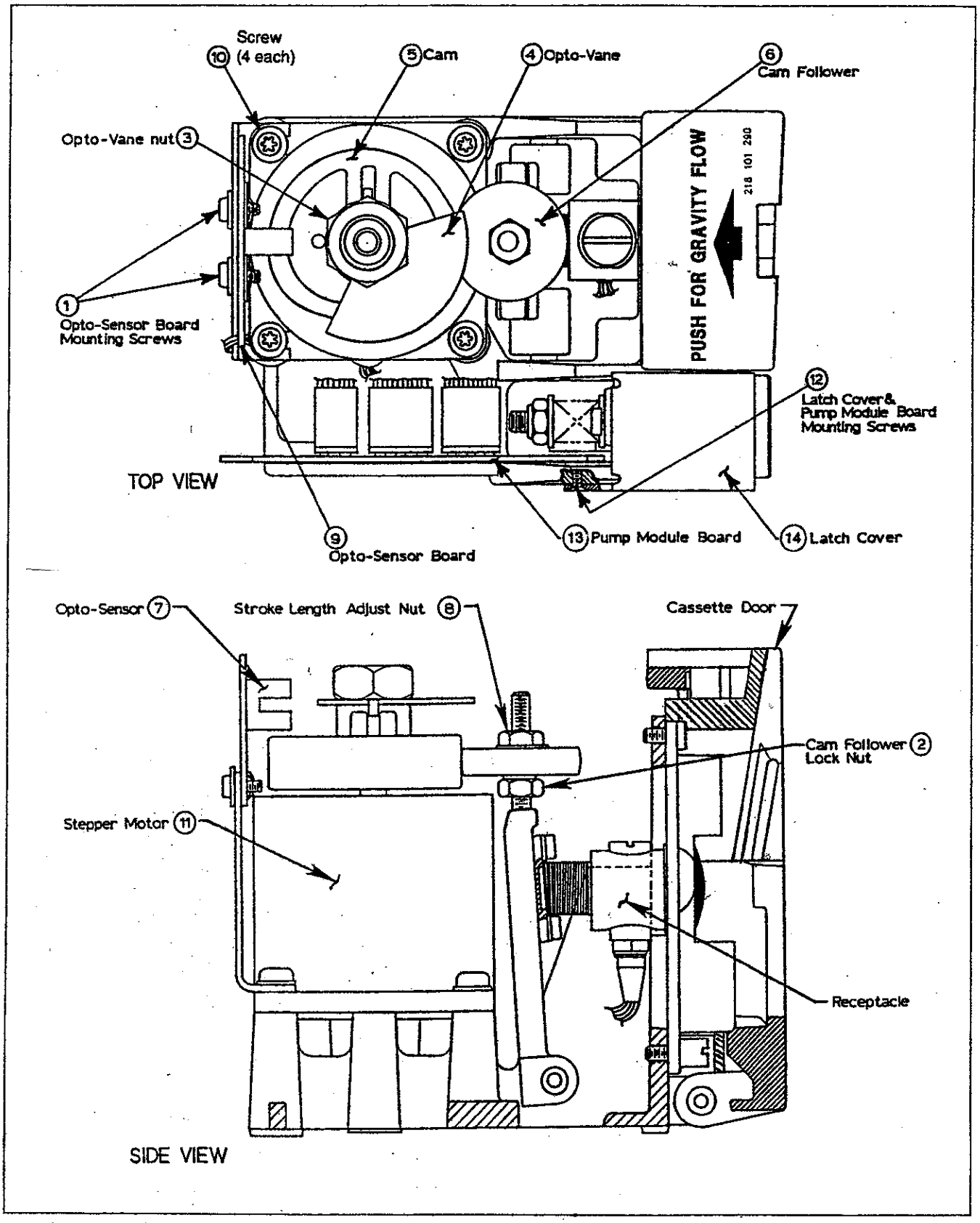
The pump module uses a stepper motor to drive a cam. The cam follower tracks the cam, causing lateral motion in the rocker arm. In turn the rocker arm alternately compresses and expands the metal bellows portion of the receptacle. The motion imparted to the receptacle by the custom contour cam provides essentially continuous, non-pulsatile fluid delivery during each delivery stroke. One milliliter is divided into 1400 increments.

The receptacle provides a fluid coupling to transfer the pumping action to the disposable cassette (refer to Figure 1). The fluid in the receptacle is a non-toxic silicone oil. Each full revolution of the cam corresponds to one pumping stroke of the disposable cassette. Each pumping stroke delivers 0.2 milliliters of fluid. The receptacle contains a pressure transducer that provides an electrical signal corresponding to the pressure in the receptacle, which represents the pressure in the disposable cassette.

Spring-loaded actuators in the receptacle are used to engage the rubber valves in the disposable cassette. The actuators assure that uniform pressure is exerted on the rubber valves such that they will open and close in a predictable manner.

The cassette door mechanism consists of the cassette door, guide plate, and latch handle. This mechanism provides proper cassette clamping, which is important for correct pumping action.

Figure 4. Pump Module



2.7

Pump Module Electronics

Electronic circuits in the pump module perform the following functions:

- Amplify the signal from the pressure transducer
- Generate the FDS signal from opto-sensor vane transitions
- Perform the CASSETTE/DOOR logic
- Convert pulses from the microprocessor board into motor drive signals

Cables from the motor, opto-sensor board, CASSETTE/DOOR switch assembly, and the receptacle transducer all plug into connectors along the top edge of the pump module board. A schematic of the pump module board is shown in Figure 24.

The pressure signal amplifier is shown in the lower left corner of the pump module board schematic, Figure 24. Op amp U5 provides an excitation current for the pressure transducer and amplifies the output of the transducer. The pressure signal output from this board represents approximately 75 mV per psi of receptacle pressure and is based on a reference voltage such that zero psi corresponds to one volt.

The majority of the circuitry on the pump module board is devoted to driving the four stepper motor field coils. Motor pulses are received from the microcomputer board on the line labeled MDP (motor drive pulses). The frequency of these pulses is determined by the processor and corresponds to the delivery rate set on the front panel. The pulses are counted by counter U1 and combined by gates U4 and U7 to switch the appropriate motor coils on and off for the half-step driving mode. Op amp U3 and driver U6 provide a constant-current drive to the energized motor coils. The motor current is adjusted with potentiometer R4.

A vane attached to the cam passes through an optical switch on the opto-sensor board which generates the Fill Delivery Stroke signal (FDS).(See opto-sensor board schematic, Figure 22.) Circuitry on this board conditions the signal from the sensor. From this signal, the microprocessor can verify motor position.

The CASSETTE/DOOR circuit is simply a microswitch which senses if the door is open or if the door is closed without a cassette inserted.

2.8

Microprocessor Board

The microprocessor board controls pump functions and communicates operating information. Two microprocessors, master and slave, are used. Both microprocessors must agree on what the pump is doing. If they do not agree, then either processor can stop the infusion and issue alerts.

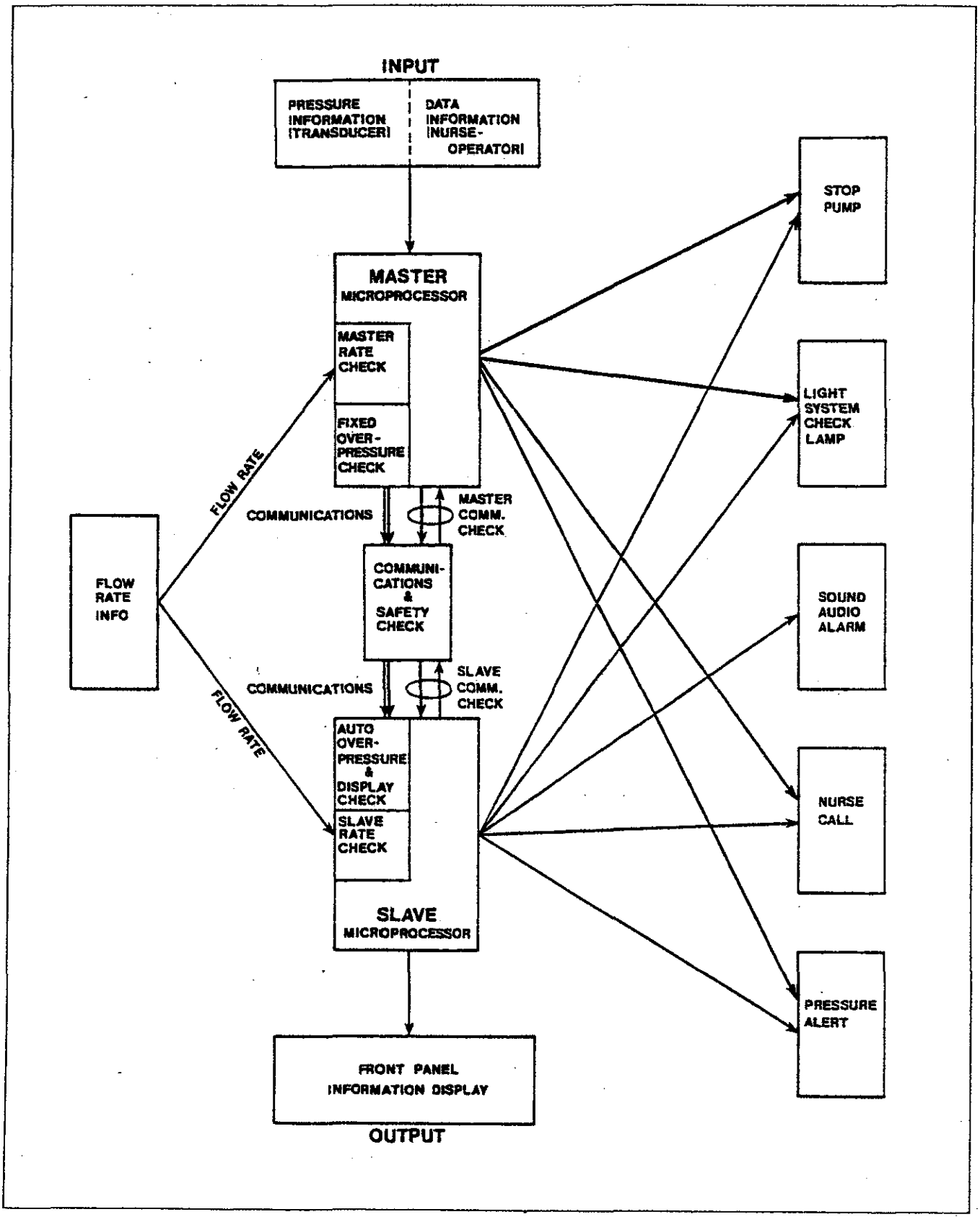
The master processor interprets the inputs and sends information to the slave processor which manages the outputs. The communication is only from master to slave using a "handshaking" protocol. The master can, therefore, detect a slave failure if the slave ever fails to "handshake" correctly. The slave expects communication from the master within a certain time period. If the communication does not occur, then the slave assumes that the master has failed. Either processor can stop the motor and light the SYSTEM CHECK alert.

The functions of the master microprocessor include reading the front panel switches, reading the A/D converter and driving the pump motor. Fixed overpressure, underpressure and air detect calculations are performed in the master microprocessor. The master checks motor position. If the opto-sensor FDS signal occurs when not expected, a SYSTEM CHECK alert will be generated. Front panel set-up information is stored in memory for two hours by keeping power to the master microprocessor for the two-hour time period.

The information read and calculated by the master is sent to the slave. The slave microprocessor then controls the display panel and does its own checks on pressure and motor position. The slave performs the differential overpressure calculation. If pressure or motor position are wrong, the slave can generate SYSTEM CHECK and PATIENT OCCLUSION alerts.

A block diagram of data flow and functions of the microprocessor board is shown in Figure 5.

Figure 5.Microprocessor Board Data Flow Diagram and Safety Check Plan



2.9

Power Management Board

The power management board takes power provided by either the battery pack or the power supply board and distributes this power to the various analog and digital circuits within the EZ-1 Pump. This function is referred to as "power management" because individual circuits are powered up and down as needed to provide for data retention of operating parameters for two hours after the power has been turned off.

The voltage regulator circuits on the power management board are:

- +5V Reference, which is maintained continuously and provides power to the on/off circuitry.
- +5V Main, which supplies voltage to the master processor and is maintained for two hours after the pump is turned off.
- +5V Machine, which powers the front panel LED displays and the slave microprocessor.
- +7.2V, which provides voltage to the stepper motor field coils.

The battery charge circuit charges the battery at a constant current when AC power is available. If AC power is removed, this same circuit automatically switches the power source to the battery with no loss of pump operation.

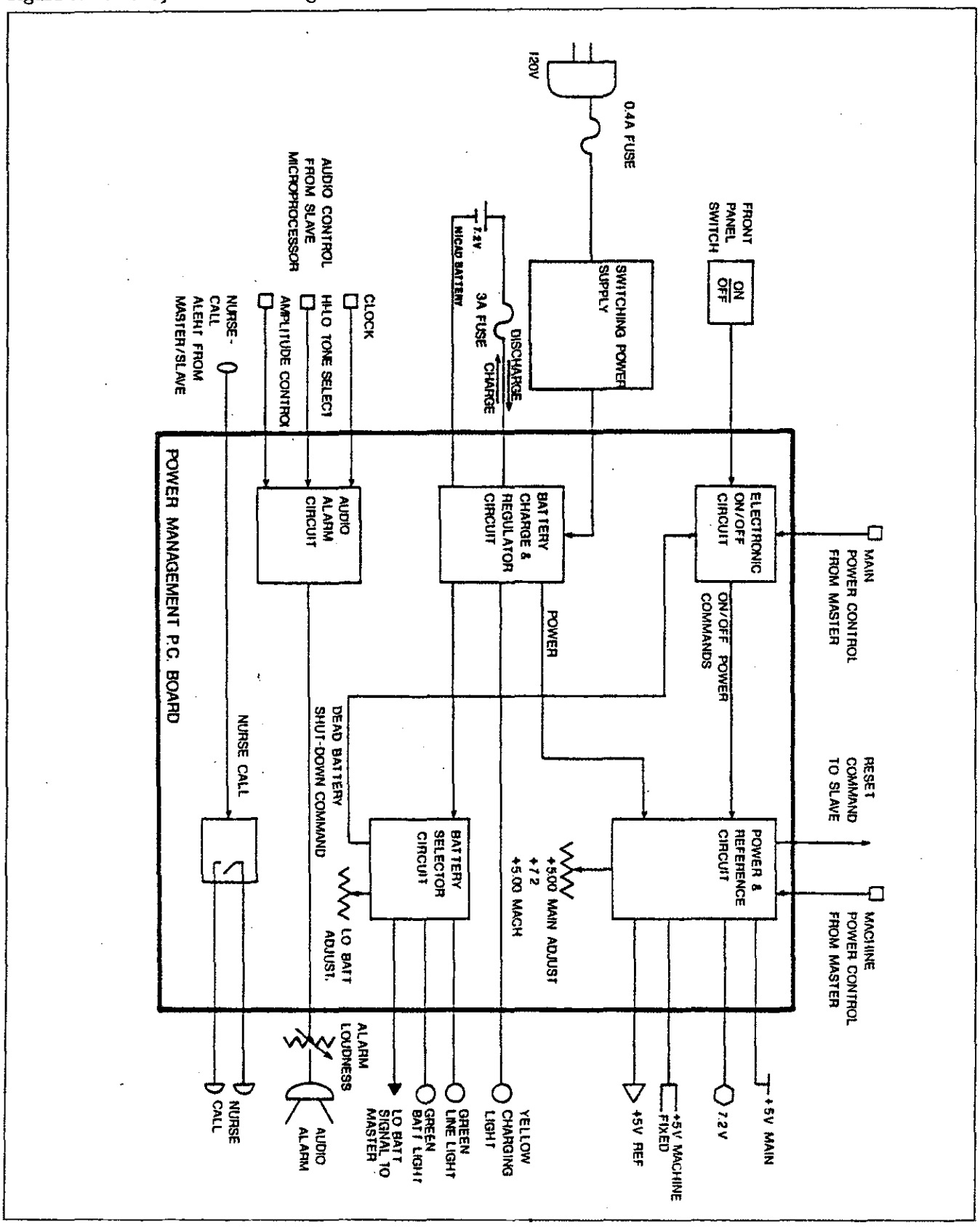
Voltage comparator circuits on the power management board monitor battery condition and generate the LOW BATTERY alert if battery voltage falls below a certain level. If the battery voltage decreases further, a dead battery shutoff circuit will turn off all power (except to the on/off circuit).

The power management board also drives the Line, Battery and Charge displays. These displays on the front panel indicate whether the pump is operating on battery or AC line power, and if the battery is being charged.

Additional functions of the power management board include the nurse call circuit and the audio alert circuit. The nurse call circuit provides a relay closure to a rear panel jack for remote monitoring of alerts. The audio alert circuit, on command from the slave microprocessor, generates the two-tone chime and delivers the amplified signal to the speaker. Volume can be controlled by the rear panel potentiometer.

A block diagram of power management functions is shown in Figure 6.

Figure 6. Power System Block Diagram



2.10

Power Supply

The power supply board converts the AC line power to a regulated DC voltage. Components on this board are the fuse and the switching power supply itself.

2.11

Display Board

The display board has all of the LED's used for numerical data, alerts, and indicators. The displays for FLOW RATE, VOLUME TO BE INFUSED, and TOTAL INFUSED are multiplexed from the slave data bus and latched onto the display board through the Character Strobe, Display Clock and Display Data lines. The Patient Occlusion Monitor display and the infusing dots display are also multiplexed. The alert LED's are not multiplexed, but are driven continuously when activated. The controls for the Front Panel Lock-out feature and the Lockout indicator light are also located on this board.

2.12

Parent Board

The parent board contains connectors for all the other boards and interconnect lines. The electrical components on this board include a diode for the power supply and filter capacitors. The ground plane on the parent board, along with the ground cables and the conductive coating on the inside of the housing, comprise the electrostatic shielding system.

2.13

Rear Panel

The rear panel holds connections to the AC power cord, nurse call jack, audio alert speaker, lockout switch, pressure switch and the volume control for the audio alert. The battery pack and battery fuse are also located on the rear panel. The battery pack consists of six nickel-cadmium D-size cells.

Section 3.0
Maintenance Schedule

3.1

Recommended Servicing

It is recommended that the following adjustment and verification procedures be performed once every six months. These procedures are described in Section 6 of this manual. The procedures should be performed in the sequence listed below.

1. Volume Delivery Verification and Adjustment
2. PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
3. AIR IN CASSETTE Alert Verification
4. SYSTEM CHECK Alert Verification
5. AC Line Leakage Check
6. Ground Continuity Check
7. Functional Verification Procedure

Section 4.0
Troubleshooting

4.1

Locating the Problem

The Fault Locator Matrix (Figure 7 on next page) facilitates the diagnosis of problems by providing a guide which matches common symptoms with their probable causes. The left column lists symptoms of problems. The top row lists the various functional modules in the pump. By selecting the symptom observed, service personnel may find the likely cause of the problem. A one (1) below a module indicates the most likely cause of the problem; a five (5) indicates that there is only a slight chance that the problem originated with that module.

This matrix is a guide to help locate the likely cause of a problem. The matrix is not all inclusive, and the causes of some problems may not be listed.

PROBABLE SOURCE	FRONT PANEL ASSEMBLY	PUMP MODULE	PROCESSOR BOARD	POWER MANAGEMENT BOARD	BATTERY PACK	POWER SUPPLY BOARD	PARENT BOARD	REAR PANEL ASSEMBLY	DISPOSABLE SET	ADJUSTMENT
SYMPTOM										
FALSE AIR IN CASSETTE ALERT		3	4						1	2
FALSE BOTTLE OR PATIENT OCCLUSION		3	4						1	2
FALSE CASSETTE NOT IN ALERT	3	1	2							
SYSTEM CHECK ALERT		1	2	3						
FRONT PANEL SWITCH FAILURE	1		2				3			
DISPLAY FAILURE	1		2	3			4			
NO "LINE" DISPLAY WITH AC APPLIED	3			2		1	4	5		
NO BATTERY POWER WHEN AC REMOVED				2	1		4	3		
COMPLETELY INOPERATIVE				2		1	4	3		
DELIVERY VOLUME INACCURACY		3							1	2
LOCKOUT INOPERATIVE	2							1		
NO CHIME ACCOMPANYING ALERT			3	2				1		
INOPERATIVE NURSE CALL FUNCTION			3	1				2		

NOTE: 1: INDICATES MOST LIKELY SOURCE OF PROBLEM
2: 2ND MOST LIKELY, ETC.

NOTE: "Front Panel Assembly" consists of control panel, display board and parent board.

Figure 7. Fault Locator Matrix

Section 5.0
Part Replacement

5.1

Power Supply Board Replacement

(Refer to Figure 9)

1. **Removal Procedure:**

   - Disconnect the pump from AC power.
   - Remove two hex head screws from the top corners of the rear panel.
   - Open the rear cover of the pump.
   - Grasp the power supply PCB, pull it towards the rear and free of the pump housing assembly.
   - Disconnect the AC power cable connector from the power supply cable.

2. **Replacement Procedure:**

   - Connect power supply cable to the AC power cable connector.
   - Carefully slide the power supply PCB into the guides at both sides of the pump.
   - Press the power supply board until the PCB is seated fully into the connector.

3. **Adjustment and Verification:**

   - Perform the following procedures which are outlined in Section 6 of this Service Manual:

     - Power Supply Voltage Adjustment
     - AC Line Leakage Check
     - Functional Verification Procedure

5.2

Power Management Board Replacement

(Refer to Figure 9)

1. **Removal Procedure:**

   - Disconnect the pump from AC power.
   - Remove two hex head screws from the top corners of the rear cover.
   - Open the rear cover of the pump.
   - Using the card ejectors, remove the power management PCB from the pump housing.

2. **Replacement Procedure:**

   - Carefully slide the power management PCB into the guides at both sides of the pump.
   - Press the card ejectors until the PCB is seated fully into the connector.

3. **Adjustment and Verification:**

   - Perform the following procedures which are outlined in Section 6 of this *Service Manual*:

     - Power Management Voltage Adjustment
     - Low Battery Threshold Adjustment
     - Functional Verification Procedure

5.3

Microprocessor Board Replacement

(Refer to Figure 9)

1. **Removal Procedure:**

   - Disconnect the pump from AC power.
   - Remove two hex head screws from the top corners of the rear panel.
   - Using the card ejectors, disconnect the power management PCB from its connectors but allow the PCB to remain in its guides.
   - Using the card ejectors, remove the microprocessor PCB from the pump housing.

2. **Replacement Procedure:**

   - Carefully slide the microprocessor PCB into the guides at both sides of the pump.
   - Press the card ejectors until the microprocessor PCB is seated fully into the connector.
   - Press the card ejectors of the power management PCB until the power management PCB is seated fully into the connector.

3. **Adjustment and Verification:**

   - Perform the following procedures which are outlined in Section 6 of this *Service Manual*:

     - PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
     - AIR IN CASSETTE Alert Verification
     - SYSTEM CHECK Verification
     - Functional Verification Procedure

Control Panel Replacement

(Refer to Figure 9)

1. **Removal Procedure:**

- Remove the power supply PCB as described in the power supply removal procedure.
- Remove the power management PCB as described in the power management PCB removal procedure.
- Remove the microprocessor PCB as described in the microprocessor PCB removal procedure.
- Remove the pump module as described in the pump module removal procedure.
- Disconnect the battery cable P701 from parent board connector J701.
- Disconnect rear panel cable P801 from parent board connector J801.
- Remove three hex head screws and one slotted screw located at the four corners of the parent board..
- Remove the control panel by pushing from the front and grasping an edge connector from the rear.
- Note location of all nylon spacers.
- Remove the nut and washer from the center of the parent board.
- Disconnect the edge connector P101 and the flat cable connector which attaches the parent board to the control panel.
- Separate the parent board from the display and control panel assembly.
- Remove five nuts, washers, and nylon spacers and separate the display board from the control panel.

2. **Replacement Procedure:**

- Place six nylon spacers on the control panel studs.
- Attach control panel to the display board with five nuts and washers.
- Connect the flex cable P501 from the display/control panel to the parent board, leaving pin 1 vacant.
- Connect edge connector P101 with the flat ribbon cable to the parent board.
- Connect cable harness assembly P1001 to the parent board.
- Place nylon spacer on the center stud and attach the parent board to the display/control assembly with a nylon washer, lock washer and a nut.
- Place the 0.5 inch nylon spacers at the upper right and upper left positions between the parent board and the control board.
- Place the one inch nylon spacers at the lower right and lower left positions between the parent board and the control board.
- Position the parent/display/control panel assembly against the inside front of the pump housing and install three hex head and one slotted screw. ***Do not over-tighten.***
- Connect P701 and P801 to the parent board.
- Install the pump module as described in the pump module replacement procedure.
- Install the microprocessor PCB as described in the microprocessor replacement procedure.
- Install the power management PCB as described in the power management replacement procedures.
- Install the power supply PCB as described in the power supply replacement procedure.
- Close the rear cover and install the two hex head screws.

3. **Verification:**

- Perform the following procedure as outlined in Section 6 of this *Service Manual*:

  - Functional Verification Procedure

5.5

Display Board Replacement

(Refer to Figure 9)

1. **Removal Procedure:**
   - Same as control panel removal.
2. **Replacement Procedure:**
   - Same as control panel replacement.
3. **Verification:**
   - Perform the following procedure as outlined in Section 6:
     - Functional Verification Procedure

5.6

Parent Board Replacement

(Refer to Figure 9)

1. **Removal Procedure:**
   - Same as control panel removal.
2. **Replacement Procedure:**
   - Same as control panel replacement.
3. **Verification:**
   - Perform the following procedure as outlined in Section 6:
     - Functional Verification Procedure

Pump Module Replacement

(Refer to Figure 9)

1. Removal Procedure:

   - Remove the 8-32 button head screw from the bottom of the pump housing.
   - Open the door, grasp the bottom of the door handle and pull the pump module completely out of the pump housing.
   - Remove the 6-32 round head screw attaching the ground cable.

2. **Replacement Procedure:**

   - Attach the ground cable to the pump module with an 6-32 round head screw.
   - Set the pump housing upright.
   - Remove two hex socket head screws from the top corners of the rear panel.
   - Open the rear cover of the pump.
   - Carefully slide the pump module into the pump housing, insuring that the pump module guide engages the guide rail.
   - Close the door, then press on the door handle until the pump module is fully seated in the pump module connector. ***Verify that the ground cables do not interfere with the pumping mechanism.***
   - Install the 8-32 button head screw in the bottom of the I.V. pump housing.
   - Close rear panel and install the two hex socket head screws.

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
     - AIR IN CASSETTE Alert Verification
     - Ground Continuity Check
     - Functional Verification Procedure

Receptacle Replacement

(Refer to Figure 10)

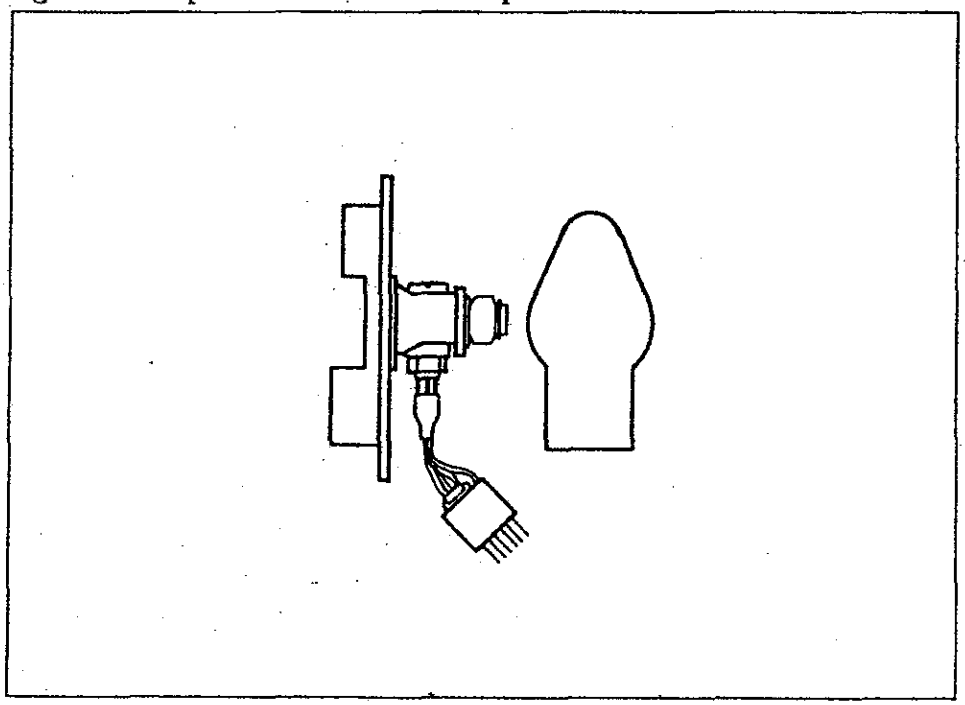
1. **Removal Procedure:**

   - Remove the pump module as described in the pump module removal procedure.
   - Using a spring hook, carefully remove the latch handle spring at the point it attaches to the base (bottom) of the module.
   - Remove the two latch cover mounting screws. Remove latch cover.
   - Slide the pump module circuit board toward the rear of the pump module.
   - Remove the hex set screw securing the latch handle to the latch handle pivot pin.
   - Remove latch handle pivot pin. Observe position of the shim between latch handle and load arm.
   - Remove latch handle and Delrin® bushing, and lower cassette door and guide plate.
   - Remove upper 6-32 screw and lower guide pin and nut, holding the receptacle in place.
   - Remove receptacle and disconnect the transducer cable.

2. **Replacement Procedure:**

   - Connect the transducer cable, white wire to white wire.
   - Carefully insert the receptacle into the pump module body with the transducer cable in the direction of the square end of the receptable hole. (See Figure 8 below.)

Figure 8. Receptacle Insertion Into Pump Module



- Align the bellows cap with the detent in the rocker arm.
- Install the upper 6-32 screw and lower guide pin and nut to secure the receptacle. Ensure that the receptacle plug and cable are positioned to prevent binding or interference with the rocker arm movement.
- Place the Delrin® bushing on the cassette door pin.
- Raise the cassette door and guide plate, insuring that the guide pin fits into the guide plate slot. Insert the door pin with the Delrin® bushing into the slot of the latch handle.
- Position latch handle and install shim and latch handle pin.
- Install the hex screw securing the latch handle to the latch handle pivot pin.
- Place the pump module circuit board in its original position and attach latch handle cover with the two screws.
- Reconnect the latch handle spring to the base of the pump module.

3. **Adjustment and Verification:**

Perform the following procedures as outlined in Section 6 in this *Service Manual*:

- CASSETTE/DOOR Switch Adjustment
- Volume Delivery Verification and Adjustment
- PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
- AIR IN CASSETTE Alert Verifications
- Cam Timing Adjustment
- Ground Continuity Check
- Functional Verification Procedure

Cam/Vane Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove pump module as described in the pump module removal procedure.
   - Rotate cam (5) to disengage opto-vane (4) from opto-sensor (7).
   - Remove two screws (1) using 3/32" allen wrench and remove opto-sensor board (9).
   - Remove and save two set screws from old cam (5) using 0.050" allen wrench.
   - Place two flat screwdrivers, one under each side, between motor and cam. Pry gently to remove cam. ***Be careful not to damage opto-vane or top of motor.***
   - Using a 3/4" wrench, remove the opto-vane (4) and nut (3) from cam.

2. **Installation Procedure:**

   - Assemble the cam (5) and opto-vane (4). Secure the hex nut (3). Be sure tang on opto-vane is inserted in slot on cam. Install two set screws in new cam. Do not tighten.
   - Clean the motor shaft with alcohol. Place two drops of Loctite® Black Max #380 adhesive around motor shaft near bottom of flat. ***Make certain adhesive does not drip down motor shaft.***
   - Slide the new cam/vane assembly onto the motor shaft and work cam around shaft to spread the adhesive between the shaft and the cam. Lightly tighten one set screw onto the flat of the motor shaft only enough to ensure cam remains in place.
   - Install opto-sensor board (9) with screws (1). Tighten screws.
   - Rotate cam (5) until the opto-vane is close to the opto-sensor (7). Loosen the set screws on the cam (5) and adjust so that the vane passes through the center of the opto-sensor. Snug both set screws, making sure that one set screw still makes contact with the flat side of the motor shaft. ***Do not exceed 1.5 in-lb. torque on cam set screws.***

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - Volume Delivery Verification and Adjustment
     - AIR IN CASSETTE Alert Verification
     - Cam Timing Adjustment
     - Ground Continuity Check
     - Functional Verification Procedure

5.10

Cam Follower Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove pump module as described in the pump module removal procedure.
   - Rotate cam (5) and vane (4) away from cam follower (6). Open cassette door.
   - Use 11/32" open end wrench to hold locknut (2) in place and a 7/16" nut driver to remove stroke length adjustment nut (8) and cam follower assembly (6).
   - Remove locknut if damaged or worn.

2. **Installation Procedure:**

   - Reinstall new locknut if necessary.
   - Reinstall cam follower assembly and stroke length adjustment nut.
   - Do not tighten locknut until adjustment and verification have been completed.

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - Volume Delivery Verification and Adjustment
     - AIR IN CASSETTE Alert Verification
     - Cam Timing Adjustment
     - Ground Continuity Check
     - Functional Verification Procedure

Opto-Sensor Board Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove pump module as described in the pump module removal procedure.
   - Loosen the two 4-40 mounting screws (1).
   - Unplug connector P902 from pump module board.
   - Remove opto-sensor board (9) from pump module.

2. **Installation Procedure:**

   - Connect plug P902 of opto-sensor board to jack J902 on the pump module board, pin 1 towards the front of the pump module.
   - Align opto-sensor board holes with slots in the rear of pump module assembly.
   - Tighten two 4-40 mounting screws after adjustment and verification have been completed.

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - AIR IN CASSETTE Alert Verification
     - Cam Timing Adjustment
     - Ground Continuity Check
     - Functional Verification Procedure

Pump Module Board Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove pump module as described in the pump module removal procedure.
   - Remove two 4-40 mounting screws (12) and latch cover (14).
   - Disconnect plugs P902, P903 and P904 from the pump module board.
   - Remove the pump module board (13).

2. **Installation Procedure:**

   - Connect plugs P902, P904 to J902 and J904 respectively. The number one pin for each connector (white wire) should be oriented toward the pump module door.
   - Connect plug P903 to J903. The number one pin, which is tagged, must be oriented toward the pump module door.
   - Install the pump module board with component side toward the pump module.
   - Install the latch cover and two 4-40 mounting screws (12).

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - CASSETTE/DOOR Switch Adjustment
     - Motor Current Adjustment
     - Pump Module Pressure Amplifier Adjustment
     - PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
     - AIR IN CASSETTE Alert Verification
     - Cam Timing Adjustment
     - Ground Continuity Check
     - Functional Verification Procedure

Motor Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove cam and vane as described in the cam/vane removal procedure.
   - Remove cam follower as described in the cam follower removal procedure.
   - Remove four 8-32 motor mounting screws (10) and washers.
   - Remove plug P903 and cable tie.
   - Remove motor (11).

2. **Installation Procedure:**

   - Install motor with the cable facing the pump module board.
   - Install a new cable tie and plug P903 into jack J903 on pump module board. The number one pin, which has a green wire, must be oriented toward the pump module door.
   - Install four 8-32 motor mounting screws with washers (10).
   - Install cam and vane as described in the cam/vane installation instructions.
   - Install cam follower as described in the cam follower installation instructions.

3. **Adjustment and Verification:**

   - Perform the following procedures as outlined in Section 6 of this *Service Manual*:

     - Motor Current Adjustment
     - Volume Delivery Verification and Adjustment
     - PATIENT OCCLUSION Alert Pressure and BOTTLE OCCLUSION Alert Pressure Adjustments
     - AIR IN CASSETTE Alert Verification
     - Cam Timing Adjustment
     - Ground Continuity Check
     - Functional Verification Procedure

CASSETTE/DOOR Switch Replacement

(Refer to Figure 10 for numbers in parentheses.)

1. **Removal Procedure:**

   - Remove pump module as described in the pump module removal procedure.
   - Remove pump module board as described in the pump module board removal procedure.
   - Remove two 2-56 mounting screws from the switch on the pump module board.
   - Unsolder and remove switch from the pump module board.
   - Clip and remove the nylon cable tie.

2. **Replacement Procedure:**

   - Position the spacer and the switch respectively over the switch mounting holes in the pump module board.
   - Install the two 2-56 mounting screws in the switch.
   - Solder the switch terminals to the board.
   - Install the pump module board as described in the pump module board installation procedure.
   - Install the pump module as described in the pump module replacement procedure.

3. **Adjustment and Verification:**

   - Perform the following procedure as outlined in Section 6 of this *Service Manual*:

     - CASSETTE/DOOR Switch Adjustment.
     - Ground Continuity Check.
     - Functional Verification Procedure.

Battery Assembly Replacement

(Refer to Figure 11)

1. **Removal Procedure:**

   - Disconnect the pump from AC power.
   - Remove two hex head screws from the top corners of the rear cover.
   - Open the rear cover of the pump.
   - Remove the four hex head battery retaining screws.
   - Remove the three button head grounding screws.
   - Remove the circuit board retaining bracket.
   - Clip and remove two battery cable ties.
   - Remove plug P701 from the parent board.
   - Lift battery pack from rear cover.
   - Observe the position of the 4 star washers between the battery plate and mounting posts.

2. **Replacement Procedure:**

   - Position the battery pack on the rear cover with the batteries against the cover and the fuse to the cable side. Be sure to install the star washers between the battery plate and the mounting posts.
   - Install the plug P701 in the parent board.
   - Install two cable ties, one in the pump bottom and the other secured to the cover battery post.
   - Position the circuit board retaining bracket over the two left screw holes.
   - Install four battery pack retaining hex head screws.
   - Connect three grounding wires to the battery pack with three button head screws.
   - Close the rear cover and install two hex head screws in the cover.

3. **Verification:**

   - Perform the following procedures as outlined in Section 6:
     - Functional Verification Procedure
   - Charge the batteries in the pump for 24 hours.

Figure 9. Major Component Locations

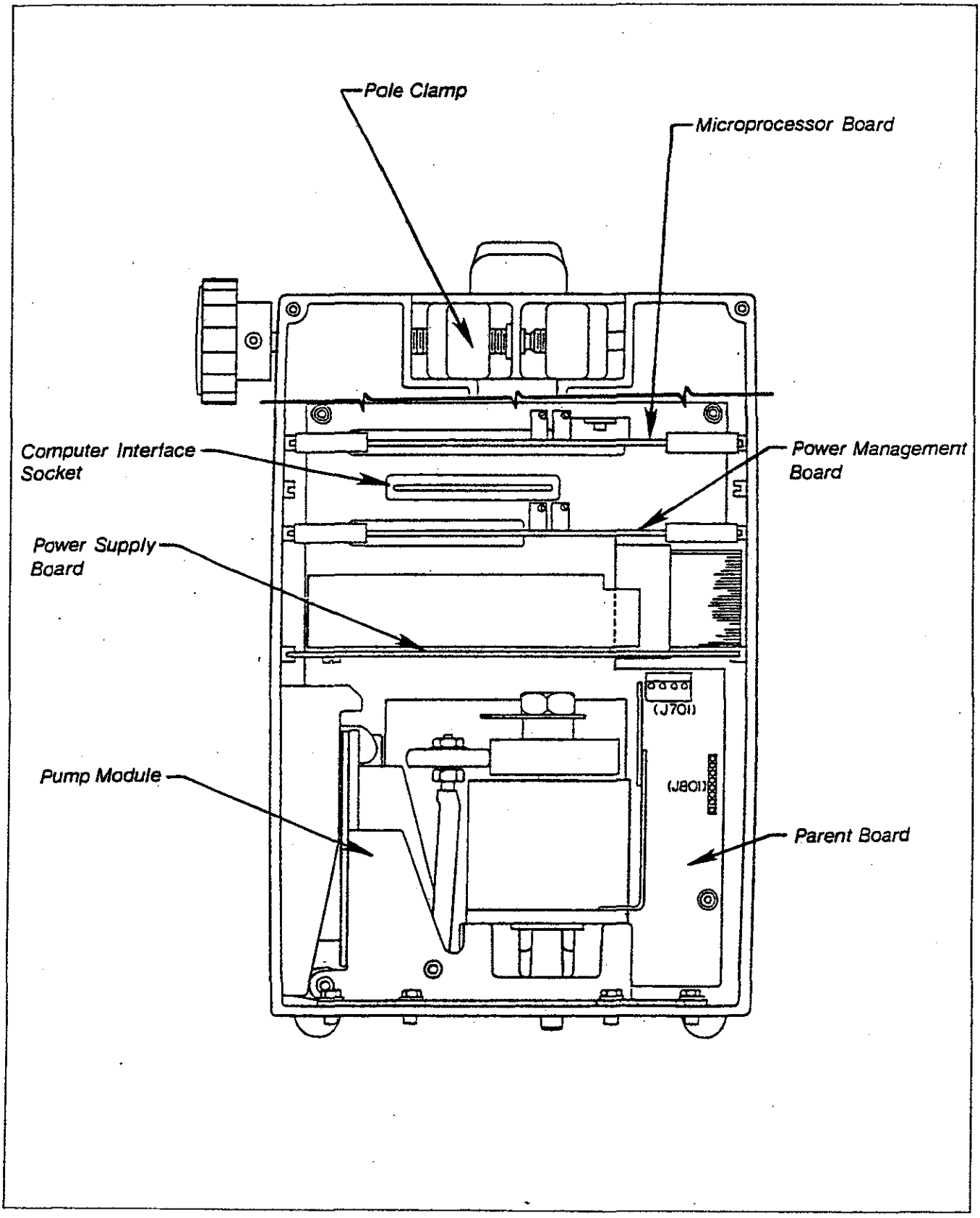


Figure 10. Pump Module

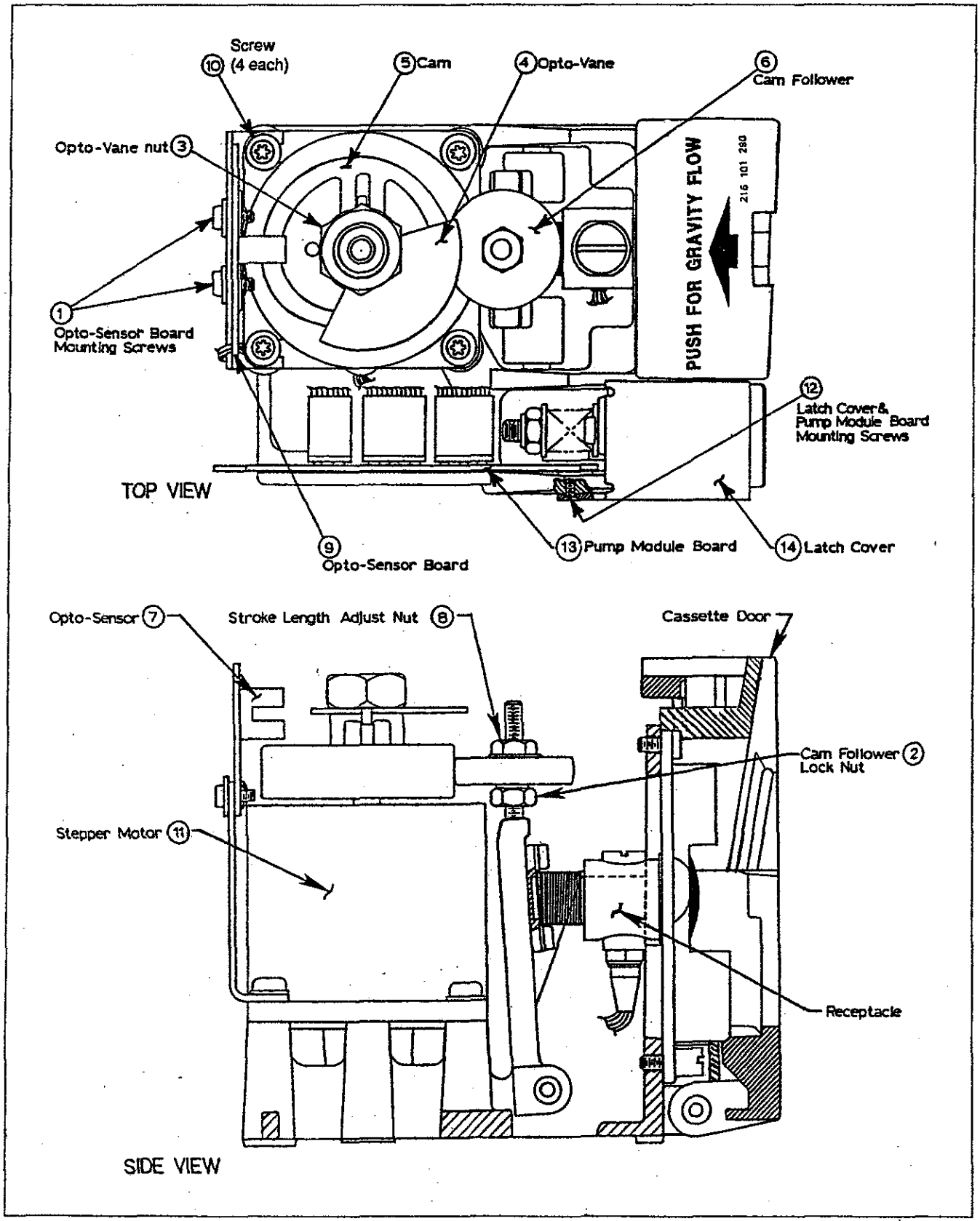
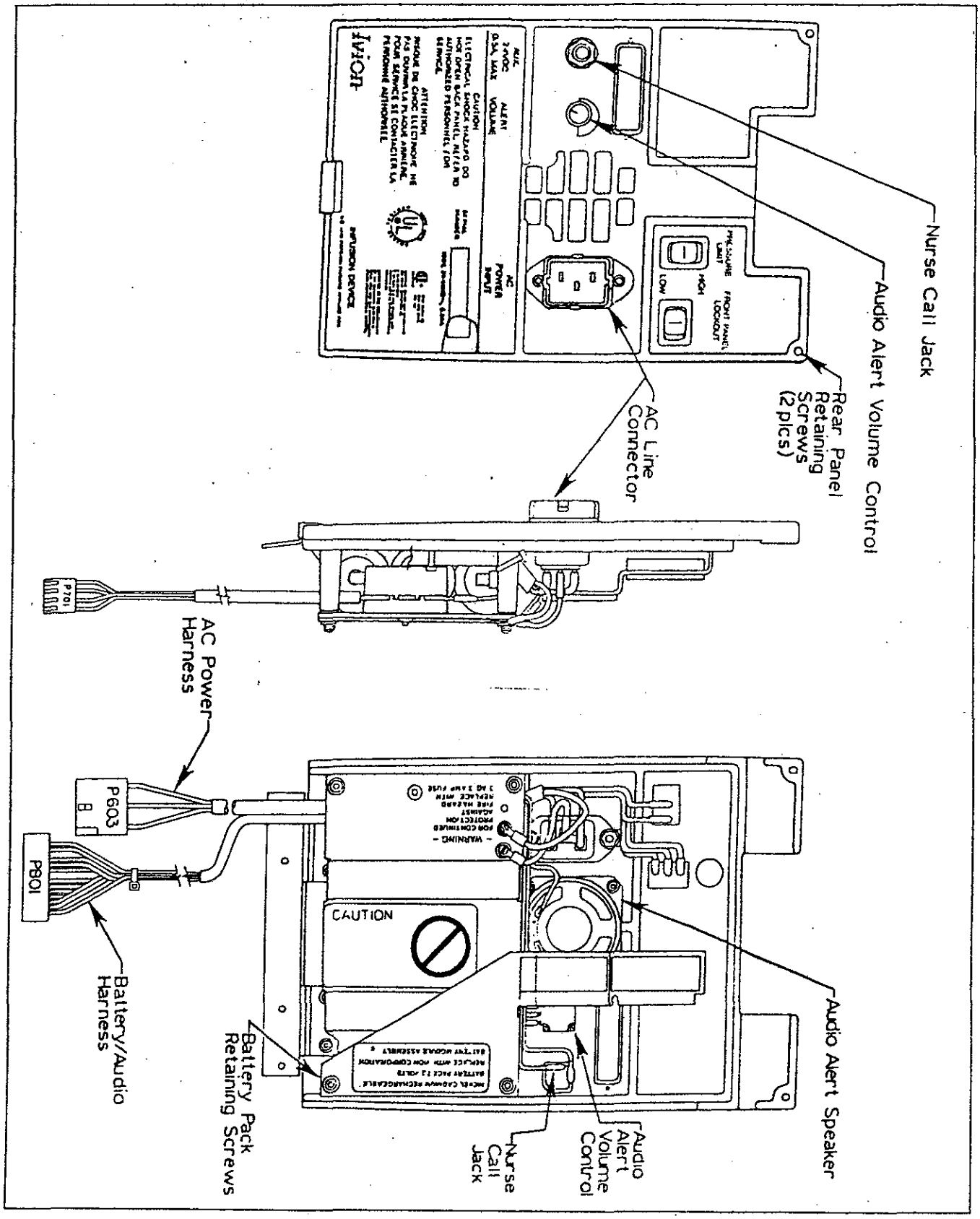


Figure 11. Rear Cover Assembly



Section 6.0
Adjustment and Verification Procedures

6.1

Functional Verification Procedure

■ ***Important:*** If the pump fails any verification procedure in Section 6.0, keep the pump out of service.

1. Connect the pump to AC power. If a cassette is in the cassette door, remove the cassette and close cassette door.
2. Verify that the CHARGE indicator on the front panel is illuminated.
3. Press the ***Power*** button on the front panel to turn the pump on.
4. Verify that the LINE indicator on the front panel is illuminated.
5. Verify that the PUMP NOT INFUSING and CASSETTE/DOOR alerts on the front panel are illuminated.
6. Verify that the audio alert is functioning.
7. Using the audio ***Alert Volume*** control located on the back of the pump, adjust the level of the audio alert from minimum to maximum.
8. If the INFUSE ALL alert on the front panel is illuminated, depress the ***Infuse All*** button on the front panel. Verify INFUSE ALL alert is now off.
9. Depress the ***Infuse All*** button. Verify that the INFUSE ALL alert is illuminated.
10. Depress the ***Infuse All*** button. Verify that the INFUSE ALL alert is now off.
11. Depress and hold each of the ***Volume To Be Infused*** buttons on the front panel. Verify that the corresponding digits on the VOLUME TO BE INFUSED display sequence from "Blank to 9" or "0 to 9".
12. Depress and hold each of the ***Flow Rate*** buttons. Verify the corresponding digits on the FLOW RATE display sequence from "Blank to 9" or "0 to 9".
13. Insert an empty cassette into the cassette door and close the door.
14. Verify that the CASSETTE/DOOR alert on the front panel is now off.
15. Using the ***Flow Rate*** buttons on the front panel, program the pump for a flow rate of 200 ml/hour.
16. Using the ***Volume To Be Infused*** buttons on the front panel, program the pump for a volume remaining of 9999.9 ml.
17. Depress the ***Infuse/Pause*** button on the front panel. Verify an AIR IN CASSETTE alert is generated within 5 seconds.

18. Remove the empty cassette from the cassette door.

19. Properly prime an I.V. set and insert the cassette into the cassette door. Close the cassette door.

20. Using the ***Flow Rate*** buttons on the front panel, program the pump for a flow rate of 600.0 ml/hour.

21. Set the ***Pressure Limit*** switch on the rear panel to the HIGH position.

22. Depress the ***Infuse/Pause*** button on the front panel.

23. Verify that the TOTAL INFUSED display on the front panel is counting up in 0.1 ml. increments.

24. Verify that the VOLUME TO BE INFUSED display on the front panel is counting down in 0.1 ml. decrements.

25. Verify that the three green "INFUSING" dots on the front panel are sequencing.

26. Verify that at least two green bars and only two amber bars on the Patient Occlusion Monitor are illuminated. Observe the position of the upper amber bar.

27. Occlude the patient-side line.

28. Verify that the PATIENT OCCLUSION alert on the front panel is illuminated.

29. Remove the occlusion on the patient-side line.

30. Depress the ***Infuse/Pause*** button on the front panel.

31. Verify that the pump has started.

32. Occlude the bottle-side line.

33. Verify that the BOTTLE OCCLUSION alert on the front panel is illuminated. Remove the bottle-side occlusion.

34. Set the ***Pressure Limit*** switch on the rear panel to the LOW position.

35. Depress the ***Infuse/Pause*** switch to start pump.

36. Verify that the upper amber bar on the Patient Occlusion Monitor is at least two positions lower than that observed in Step 26.

37. Toggle the ***Front Panel Lockout*** switch on the rear panel.

38. Verify that the LOCK indicator on the front panel is illuminated.

39. Depress the ***Power*** switch. Verify that the pump does not turn off.

40. Occlude the patient-side line.

41. Verify the Lock indicator goes out when the PATIENT OCCLUSION alert occurs.

42. Remove occlusion in patient-side line.

43. Depress the ***Clear Total*** button on the front panel.

44. Verify that the TOTAL INFUSED display is reset to 0.0 ml.

45. Using the ***Volume To Be Infused*** buttons on the front panel, program the pump for a volume remaining of 1.0 ml.

46. Depress ***Infuse/Pause*** on the front panel.

47. Verify that the VOLUME TO BE INFUSED display counts down to 0.0 ml.

48. Verify that the KVO ≤ 1 ML/HR alert is illuminated on the front panel.

49. Press the ***Power*** button on the front panel to turn the pump off.

50. Disconnect the pump from AC power.

51. Press the ***Power*** button on the front panel to turn the pump on.

52. Verify that the BATTERY indicator on the front panel is illuminated.

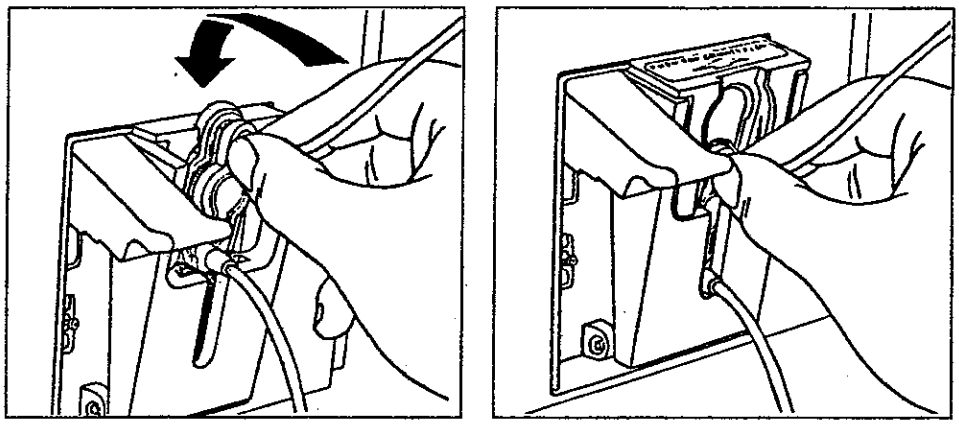
53. Allow the pump to operate at least two minutes on battery power. Verify a LOW BATTERY Alert does not occur and pump continues to operate. (See Chapter 15 of EZ-1 Pump *Operation Manual* for "Battery Operation.")

54. Press the ***Power*** button on the front panel to turn the pump off. Close the patient side clamp.

55. Open the cassette door.

56. Push the guide plate on the cassette door toward the pump. Slowly release the guide plate.

57. Verify that the guide plate springs fully forward as shown below. If the guide plate binds or does not return to its proper position, gravity flow may occur when the cassette door is open. ***If this condition exists, keep the pump out of service.***



58. Remove the cassette and close the cassette door.

6.2

Volume Delivery Verification and Adjustment

■ ***Note:*** This section establishes the standard conditions for verification of volume delivery accuracy.

Equipment Required:

- Pump module extender board
- Covered container capable of holding about 100 ml.
- Disposable I.V. set (not a burette or filter set), such as: IV1A01, IV1A02, IV1A03, IV1A04, IV1A08.
- Electronic balance (0.1 gm resolution)
- 7/16" hex driver or socket wrench
- 3/32" allen wrench
- 11/32" open end wrench
- I.V. solution container with water free of air

Set-Up:

1. Remove the pump module and extend it using the pump module extender board.

2. Set up the pump with a properly primed I.V. set and an 18 gauge x 1 1/2" needle. Hang solution container 24 inches above the pump module. Open all clamps on the I.V. set tubing.

Verification:

3. Allow the electronic balance to warm up according to manufacturer's recommendation.

4. Place the covered container on the electronic balance and tare the balance to this weight.

5. Turn the pump on using the ***Power*** button on the front panel.

6. Remove the container from the balance and place it on a clean surface. Insert the needle into the covered container.

7. Set the FLOW RATE to 600 ml/hr and set the VOLUME TO BE INFUSED to 20 ml. Press ***Infuse/Pause*** to start the delivery.

8. Wait until the KVO alarm is activated and the delivery is complete. Immediately remove the needle from the container. Any hanging drop on the tip of the needle should drop into the container when the needle is pulled from the covered container.

9. Determine the amount of fluid delivered by weight:
   1 gm = 1 ml of water.

   The pump has delivered within 2 per cent if the fluid weighs 19.6 - 20.4 grams. The pump has delivered within 5per cent if the fluid weighs 19.0 - 21.0 grams.

Adjustment:

10. If the delivery varies from the expected weight, adjust the cam follower up to decrease the delivery, or down to increase the delivery. First loosen the locknut under the cam follower (11/32 wrench) and then adjust the upper nut (7/16 wrench):

    - 3/4 turn CW = approximately 1% increase in volume delivered
    - 3/4 turn CCW = approximately 1% decrease in volume

11. Retighten the locknut under the cam follower.

12. Repeat the above verification and adjustment procedures until correct delivery is obtained.

Factors Affecting Volume Delivery Accuracy:

Determining volume delivery accuracy in a clinical setting is difficult because the only readily available points of comparison are burettes and I.V. solution containers. Using burettes or solution containers to measure delivery can result in an error of five per cent or more, making these devices inappropriate for determining pump accuracy unless extreme delivery errors exist.

The delivery accuracy of infusion pumps can be affected by a variety of factors. Some factors are unique to specific types of pumps. The following list can help you diagnose the cause for a volume delivery inaccuracy.

Low Volume Delivery:

These factors individually, or in combination, may cause the volume delivered to be low:

1. Pressure or restriction on the patient side line. (Typically caused by clogged in-line filter, almost completely closed clamp, or small patient catheter in conjunction with high flow rate.)

2. Vacuum in the bottle side line due to inadequate venting into the solution container.

3. Solution container too low with respect to the patient.

4. Particulate matter in the solution, causing improper cassette function.

5. Air in the cassette, below the detectable limit.

6. Restriction in the bottle side line. (Typically from a microdrop cannula.)

7. Dirty receptacle membrane or actuator pins.

8. Viscous solutions.

9. Incorrect flow rate setting by the operator.

High Volume delivery:

These factors individually, or in combination, may cause the fluid volume delivered to be high:

1. Particulate matter in the solution, causing improper cassette function.

2. Incorrect flow rate setting by the operator.

AIR IN CASSETTE Alert Verification

Method 1:

Equipment required:

- I.V. Set with Y-site in bottle side line
- Microliter syringe
- I.V. Solution container with water free of air

1. Press the ***Power*** button to turn on the pump.
2. Prime the cassette, carefully removing all air. An I.V. set with a bottle-side Y-site must be used. The solution container should be hung at a low height, approximately level with the cassette.
3. Insert the cassette into the cassette door and close the door.
4. Set the flow rate to 350 ml/hr.
5. Press the ***Infuse/Pause*** button to start the pump.
6. After at least 1.0 milliliter has been delivered, inject 20 microliters of air into the Y-site on the bottle side line. Make sure that all of the injected air travels into the cassette. Invert and tap the Y-site if necessary. The pump should continue running with no alerts. Allow the pump to deliver at least 2.0 additional milliliters of fluid.
7. Stop the pump and remove the cassette. Reprime the cassette, carefully removing all air.
8. Reinsert the cassette and start the pump again.
9. After at least 1.0 milliliter of fluid has been delivered, inject 100 microliters of air into the bottle-side Y-site. Make sure that all of the injected air travels into the cassette. Verify that the AIR IN CASSETTE alert activates within 10 seconds.
10. If the pump detects or fails to detect air at improper levels, perform the Cam Timing Adjustment procedure, and then recheck the AIR IN CASSETTE Alert Verification per this procedure.

Method 2:

Equipment required:

- Ivion IVSK09 Calibration Board

1. Using the *Operation Manual* for the Ivion IVSK09 Calibration Board, adjust cam timing (Mode 4).

6.4

Cam Timing Adjustment

Method 1:

Equipment required:

- 3/32" allen wrench

1. If a pump has failed the AIR IN CASSETTE Alert verification test described in sub-section 6.3, then the pump needs adjustment. Air detect sensitivity is set by adjusting cam timing.
2. Loosen the two mounting screws on the opto-sensor board.
3. Adjustment:
   - To increase sensitivity, move the opto-sensor board toward the pump module board.
   - To decrease sensitivity, move the opto-sensor board away from the pump module board.
4. Retighten the opto-sensor board mounting screws. Insure that the vane clears the opto-sensor and all the opto-sensor board components.
5. Repeat the AIR IN CASSETTE Alert Verification procedure after each adjustment.

Method 2:

Equipment required:

- Ivion IVSK09 Calibration Board

1. Using the *Operation Manual* for the Ivion IVSK09 Calibration Board, adjust cam timing (Mode 4).

BOTTLE OCCLUSION Alert Pressure and PATIENT OCCLUSION Alert Pressure Adjustments

Method 1:

Equipment required:

- Digital voltmeter with peak-hold capability (Fluke 8024B or equivalent)
- 3/32" allen wrench
- Pump Module Extender Board
- Jumper wires

Basic equipment setup:

1. Unplug the AC line cord from the pump.
2. Open the rear cover of the pump.
3. Extend the pump module using the pump module extender board. Do not install a cassette.
4. Disable the AIR IN CASSETTE alert by connecting a jumper wire from TP5 to TP6 on the microprocessor board.
5. The CASSETTE/DOOR alert must be disabled so that the pump will run without a cassette. To do this, connect a clip lead jumper wire from a ground pin on the pump module extender board to connector pins 11 and 12 on the extender board. An attachment pin may have to be soldered onto the extender board at pins 11 and 12.

Microprocessor Board BOTTLE OCCLUSION Alert Pressure adjustment:
(also referred to as "underpressure" ["UP"] adjustment)

6. Plug the AC line cord into the rear cover of the pump.
7. Connect a peak-hold voltmeter to the pressure signal test points on the microprocessor board so that the valley of the pressure signal (receptacle signature curve) can be captured. Connect red lead to pin 6, black lead to pin 4.
8. Press the ***Power*** button to turn on the pump.
9. Set the flow rate to 350 ml/hr and press ***Infuse/Pause*** to start the pump. Allow the pump to run for at least two minutes.

10. Reset the peak-hold DVM. Measure and record the ***absolute value*** of the pressure curve valley voltage.

11. Calculate the UP threshold by subtracting 0.45 volts from the valley voltage of the pressure curve measured above.

12. Connect a DC voltmeter to the UP threshold test point on the microprocessor board. Connect red lead to pin 7, black lead to pin 6.

13. Adjust the UP threshold by turning the UP pot on the microprocessor board so that the voltmeter displays the UP threshold calculated above.

    UP Threshold = (valley voltage of receptacle signature curve) - (0.45 volts) ± 0.02 volt

Microprocessor Board PATIENT OCCLUSION Alert Pressure adjustment:
(also referred to as "overpressure," ["OP"], adjustment)

14. Connect the peak-hold voltmeter leads to the microprocessor board so that the peak of the pressure curve can be monitored. Connect red lead to pin 4, black lead to pin 6. Reset the peak-hold. Measure and record the peak voltage of the pressure curve.

15. Calculate the OP threshold by adding 1.97 volts to the peak voltage of the pressure curve measured above.

16. Move the voltmeter leads to the fixed OP threshold test points on the microprocessor board. Connect red lead to pin 9, black lead to pin 6. Adjust the OP pot on the microprocessor board so that the voltmeter displays the OP threshold voltage calculated above.

    OP Threshold = (peak voltage of receptacle signature curve) + (1.97 volts) ± 0.02 volt

17. Press the ***Power*** button to turn off the pump.

18. Disconnect the pump from AC power.

19. Disconnect the voltmeter leads and jumper wires.

20. Remove the jumper wire which was attached in step 5.

21. Reinsert the pump module into the housing, and close the rear cover.

Method 2:

Equipment required:

- Ivion IVSK09 Calibration Board

1. Using the Ivion IVSK09 *Operation Manual*, adjust the underpressure, (Mode 2).

2. Using the IVSK09 *Operation Manual*, adjust the overpressure, (Mode3).

SYSTEM CHECK Alert Verification

Equipment Required:

- 3/32" allen wrench
- Disposable I.V. set

1. Disconnect the pump from AC power.
2. Open the rear cover of the pump.
3. Turn on the pump by pressing the ***Power*** button.
4. Install a primed I.V. set.
5. Set the flow rate to 600 ml/hr and the VOLUME TO BE INFUSED to 9999.9 ml.
6. Press the ***Clear Total*** button.
7. Press the ***Infuse/Pause*** button to start the pump.
8. Allow the pump to infuse at least 1.0 ml.
9. Manually stop the cam from turning by grasping it from the back of the pump.
10. Verify that the SYSTEM CHECK alert is activated.
11. To reset the pump after this alert, close the patient-side clamp and open the cassette door.
12. Close the rear cover.

6.7

AC Line Leakage Check

Equipment required:

- Electrical safety analyzer

1. Insert a primed I.V. set into the cassette door.
2. Turn the pump on using ***Power*** button on the front panel.
3. Set the pump FLOW RATE to 135 ml/hr. Set the VOLUME TO BE INFUSED to 1000 ml.
4. Connect the AC power cord to the safety analyzer following the procedures for the analyzer.
5. Press the ***Infuse/Pause*** button on the front panel.
6. While the pump is pumping at 135 ml/hr, measure the open ground current for normal and reverse polarity.
7. Open ground current must be less than 100 micro-amperes for both measurements.

6.8

Ground Continuity Check

Equipment Required:

- Ohmmeter capable of measuring milliohms.

1. Set up meter to measure milliohms.
2. Connect the AC power cord to the pump. (Do not connect the cord to AC power.)
3. Connect one lead of the meter to the ground prong on the power cord.
4. Connect the other lead of the meter to the allen head screw on the bottom of the pump.
5. The resistance between these two points should be less than 150 milliohms.

■ ***Note:*** If the AC power cord is not available, measure the resistance between the ground prong on the pump's AC receptacle and the allen head screw. This resistance should be less than 100 milliohms.

6.9

FLOW RATE (Timing) Verification

Equipment Required:

- Disposable I.V. set
- Pump module extender board
- Stopwatch

1. Remove pump module and extend it using the pump module extender board.
2. Install a primed I.V. set.
3. Turn the pump on using the ***Power*** button on the front panel.
4. Set the FLOW RATE to 10.0 ml/hr.
5. Press the ***Infuse/Pause*** button to start the pump.
6. As the trailing edge of the vane on the motor shaft passes the optosensor, the pump will start a high-speed refill stroke. At the start of this refill stroke, start the stopwatch.
7. Stop the stopwatch on the next refill stroke, as the vane again passes the opto-sensor.
8. The time for one complete motor revolution should be 70.56 - 73.44 seconds.

6.10

Power Management Voltage Adjustment

Equipment Required:

- 3/32" allen wrench
- DC voltmeter

1. Connect the pump to AC power.
2. Open the rear cover of the pump.
3. Turn the pump on using the ***Power*** button on the front panel.
4. Connect the positive lead of the DC voltmeter to TP401-10 on the power management board. (Refer to Figure 19.)
5. Connect the negative lead of the DC voltmeter to TP401-8 on the power management board.
6. Adjust R15 on the power management board until the voltage displayed on the voltmeter is 5.00 VDC.
7. Move the positive lead of the voltmeter to TP401-4 on the power management board. Verify that the voltage displayed on the voltmeter is 5.0 VDC ± .1 VDC. If the voltage is outside this range, repair is required.
8. Move the positive lead of the voltmeter to TP401-9 on the power management board. Verify that the voltage displayed on the voltmeter is 7.2 VDC ± .14 VDC. If the voltage is outside this range, repair is required.
9. Disconnect the voltmeter from the pump and close the rear cover of the pump.

6.11

Low Battery Threshold Adjustment

Equipment Required:

- Pump module extender board
- Adjustable power supply: 0-10 VDC @ 1 A
- DC voltmeter
- 3/32" allen wrench
- Disposable I.V. set

1. Remove AC power from the pump.
2. Open the rear cover.
3. Remove the pump module and extend it using the pump module extender board.
4. Unplug the battery cable from the parent board (J701). (Refer to Figure 27.)
5. Connect the leads of the adjustable power supply to J701 on the parent board, positive to pin 4, negative to pin 1.
6. Connect a DC voltmeter positive lead to TP401-2 and negative lead to ground at TP401-8 on the power management board.
7. Insert primed I.V. Set. Set the power supply to eight volts and start the pump running at 200 ml/hr., with VOLUME TO BE INFUSED = 9999.9 ml.
8. Slowly turn the adjustable power supply voltage down. The LOW BATTERY alert should activate between 6.90 and 7.0 volts as shown on the voltmeter.
9. Reset the power supply to 8 volts. Repeat step 8 and adjust potentiometer R41 on the power management board until the correct threshold is obtained. (Refer to Figure 19).
10. Remove the power supply leads and plug the battery cable back into J701.
11. Remove the pump module extender board and reinstall the pump module in the housing.
12. Close the rear cover.

6.12

Power Supply Voltage Adjustment

Equipment Required:

- 3/32" allen wrench
- DC voltmeter
- Power Supply extender board

1. Disconnect the pump from AC power.
2. Open the rear cover of the pump and remove the power supply board.
3. Plug the power supply board into the extender board and insert the extender board into the power supply board connector.
4. Reconnect the AC line power.
5. Connect a DC voltmeter to the output terminals of the power supply.
6. Adjust the potentiometer on the power supply until the voltmeter reads 10.75 v ± 0.05 v.
7. Disconnect AC power. Remove the extender card and reinstall the power supply board into the pump.

Motor Current Adjustment

Equipment Required:

- Pump module extender board
- DC ammeter
- Disposable I.V. set
- 3/32" allen wrench

1. Turn the pump off using the ***Power*** button on the front panel.
2. Remove the pump module.
3. Insert the pump module extender board into the pump module slot. Verify that the extender board is firmly seated in the pump module edge connector with the test pins toward the front of the pump housing.
4. Connect the pump module to the ribbon cable on the pump module extender board.
5. Remove the jumper from the extender board. Connect the positive lead of a DC ammeter on the terminal nearest the pump housing. Connect the negative lead of the ammeter to the other terminal. (Polarity is indicated on the extender board.)
6. Connect the pump to AC line power.
7. Properly prime an I.V. set and insert the cassette into the cassette door. Close the cassette door.
8. Turn pump on using the ***Power*** button on the front panel.
9. Program the pump for a FLOW RATE of 125 ml/hour and a VOLUME TO BE INFUSED of 9999.9 ml.
10. Start the pump infusing by depressing the ***Infuse/Pause*** button on the front panel.
11. Adjust R4 on the pump module board until the reading on the ammeter is 275 mA during the delivery portion of the pumping stroke.
12. Turn the pump off using the ***Power*** button on the front panel.
13. Disconnect the pump from the AC line power.

14. Remove the cassette.

15. Remove the pump module extender board. Be sure to replace the jumper on the extender board.

16. Reinstall the pump module.

6.14

Battery Charge Current Check

Equipment Required:

- DC ammeter
- 3/32" allen wrench

1. Disconnect the pump from AC power.

2. Open the rear cover of the pump.

3. Remove the four allen head screws holding the battery pack mounting plate.

4. Remove the 3 amp fuse located behind the battery pack mounting plate.

5. Connect the positive lead of the DC ammeter to the fuse terminal nearest the pump and the negative lead to the terminal wired to the battery pack.

6. With AC power supplied to the system the current should be 250-340 mA. This is the charging current to the batteries.

7. Disconnect from AC power.

8. Remove the ammeter, replace the fuse, and remount the battery pack mounting plate on the rear panel.

9. Close rear cover.

Nurse Call Jack Verification

Equipment Required:

- Ohmmeter
- 1/4 inch stereo phone plug

1. Plug the stereo phone plug into the nurse call jack.
2. Connect the ohm meter to the "Tip" and "Ring" terminals of the jack.
3. Turn the pump on using the ***Power*** button on the front panel.
4. Initiate an alert by opening the cassette door. The reading on the ohmmeter should be less than 5 ohms.
5. Insert a primed cassette and depress ***Infuse/Pause*** button. The alert should clear, and the reading on the meter should indicate an open circuit.
6. Disconnect meter and phone plug.

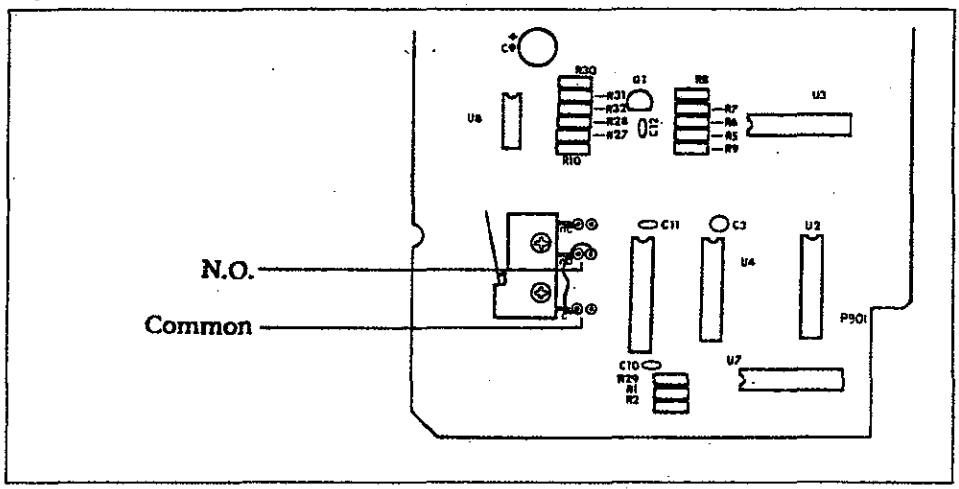
CASSETTE/DOOR Switch Adjustment

The CASSETTE/DOOR switch is located on the pump module circuit board.

Equipment Required:

- Ohmmeter

Figure 12. Ohmeter Connection To Latch Switch



Adjustment Procedure:

1. Attach one ohmmeter lead to the normally open contact and the other lead to the common contact of switch 2. (See figure 12.)

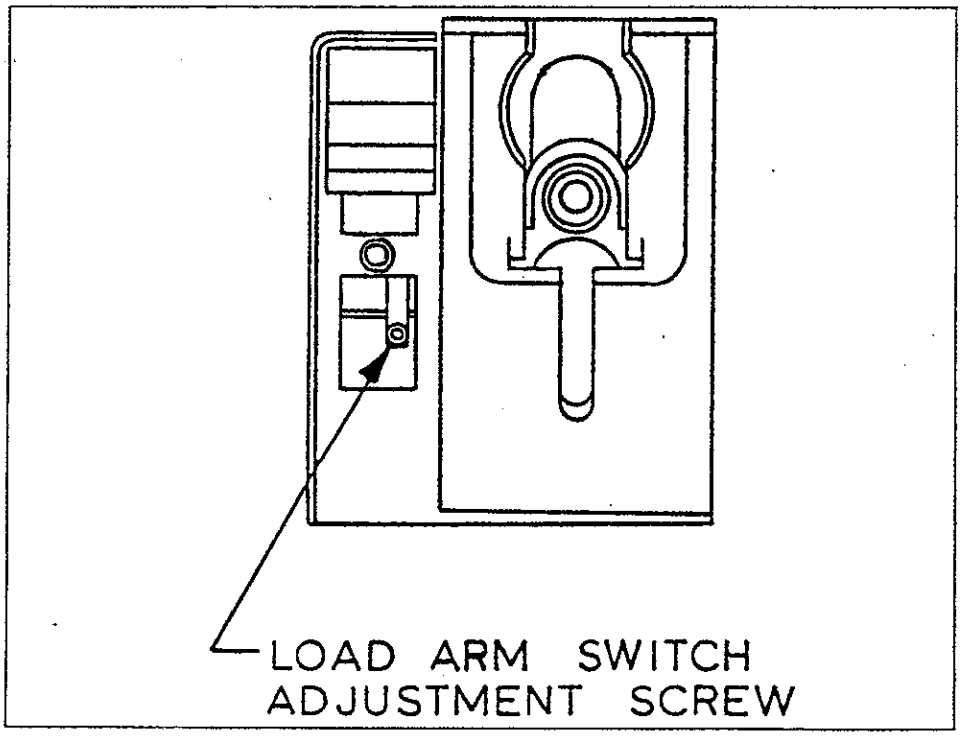
2. With a cassette in place, close the latch handle and observe that continuity occurs at approximately 15° before the latch handle is fully closed.

3. To obtain the results in step 2, adjust the 2-56 hex head adjustment screw. (See figure 13.)

4. Repeat step 3. Apply Loctite® 290 thread locker after adjustment is complete.

5. Remove the cassette and install the pump module in the pump housing.

Figure 13. Load Arm Switch Adjustment Screw



6.17

Pump Module Pressure Amplifier Adjustment

There are two potentiometers on the pump module board for pressure signal amplifier adjustment. These potentiometers do not normally require adjustment. Adjustment is necessary only if the original adjustments have been disturbed or if improper operation of the pump module board is suspected. A special Transducer Simulator board is required for these adjustments.

Method 1:

Equipment required:

- Transducer Simulator
- Pump module extender board
- DC voltmeter

1. Disconnect the pump from AC power.
2. Open the rear cover of the pump.
3. Extend the pump module using the pump module extender board.
4. Attach a DC voltmeter to the pressure signal test points on the microprocessor board. Connect the red lead to pin 4, black lead to pin 6.
5. Unplug the pressure transducer connector from the pump module board (J904).
6. Plug the transducer simulator into pump module board connector J904.
7. Connect the pump to AC power.
8. Press the ***Power*** button to turn on the pump.
9. Set the transducer simulator switch to the "0 psi" position.
10. Adjust the offset pot on the pump module board until the voltmeter reads 1.00 ± 0.01 volts.
11. Change the switch on the transducer simulator to the "35 psi" position.
12. Adjust the span pot on the pump module board until the voltmeter reads 3.66 ± 0.01 volts.
13. Repeat the last four steps above until the span and offset readings stabilize.

14. Press the ***Power*** button to turn off the pump.

15. Remove the transducer simulator from the pump module connector and plug the pressure transducer cable back into J904.

16. Disassemble setup by disconnecting the voltmeter leads, reinserting the pump module into the housing, and closing the rear cover.

Method 2:

Equipment required:

- Ivion IVSK09 Calibration Board

1. Using the Ivion IVSK09 *Operation Manual*, adjust the span and offset parameters, (Mode 0).

Section 7.0
Schematics and Assembly Diagrams

7.1

This section contains illustrations of the EZ-1 Pump schematics and assembly diagrams for your reference.

Figure 14. Display Board Schematic

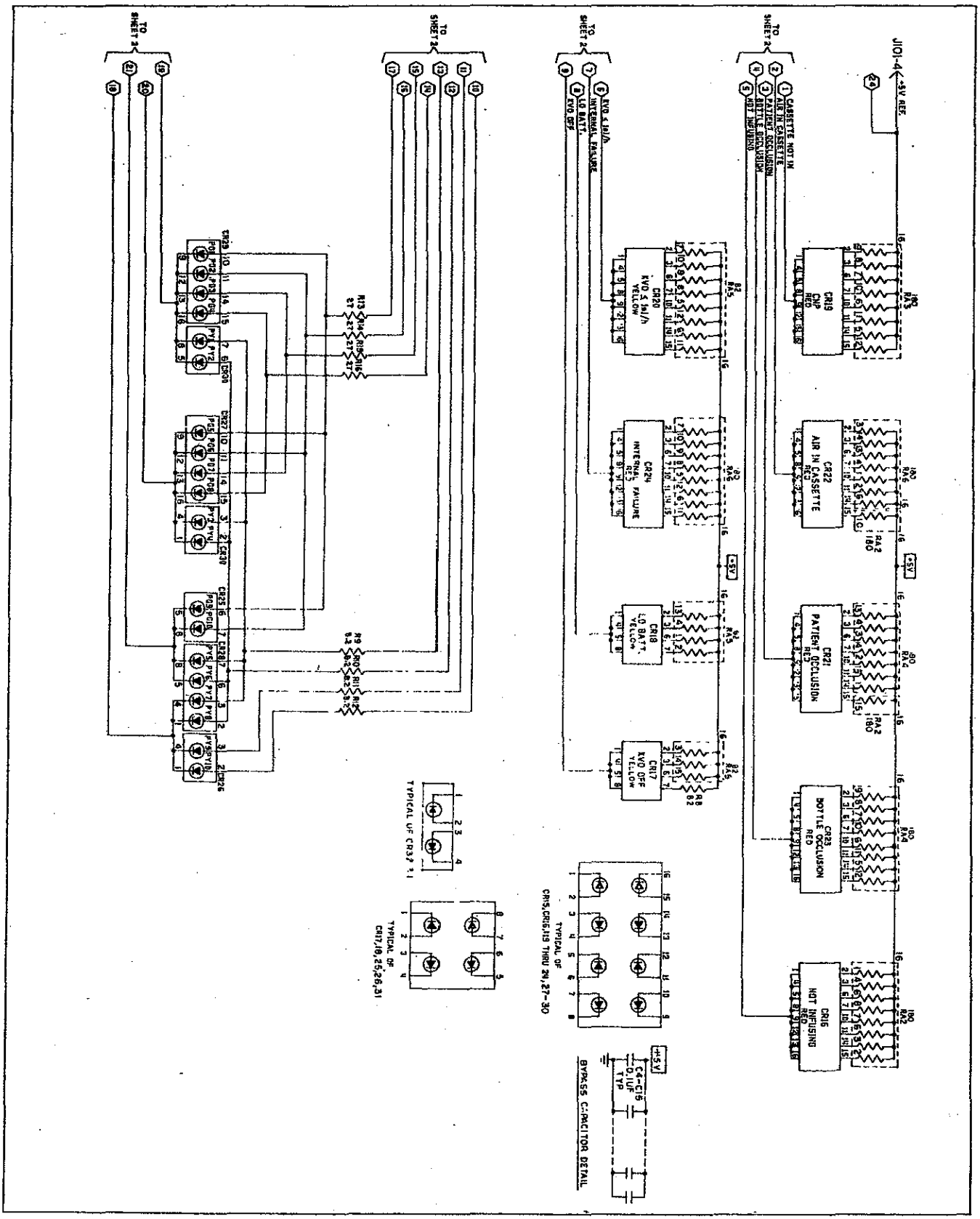


Figure 14 (cont.). Display Board Schematic

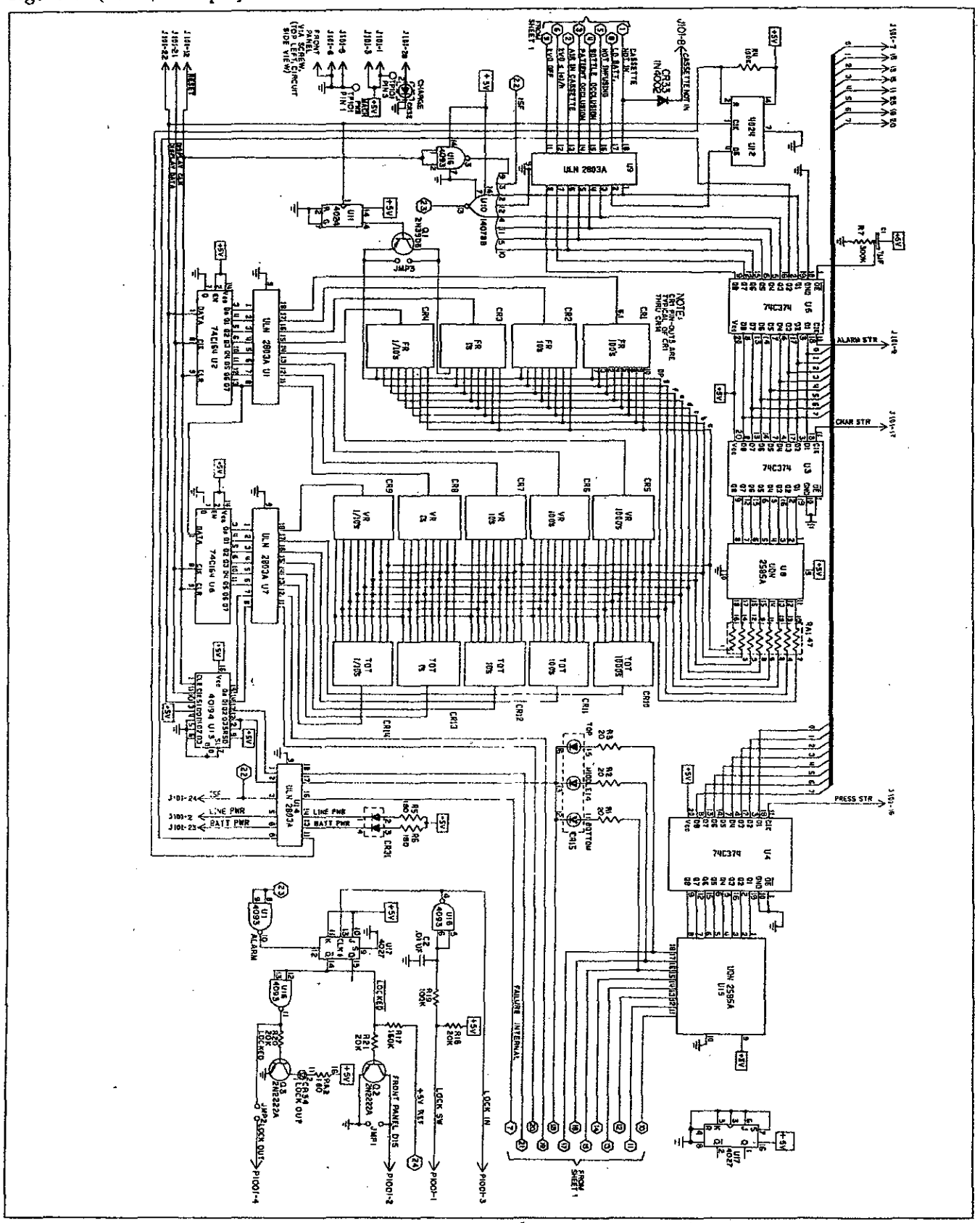


Figure 15. Display Board

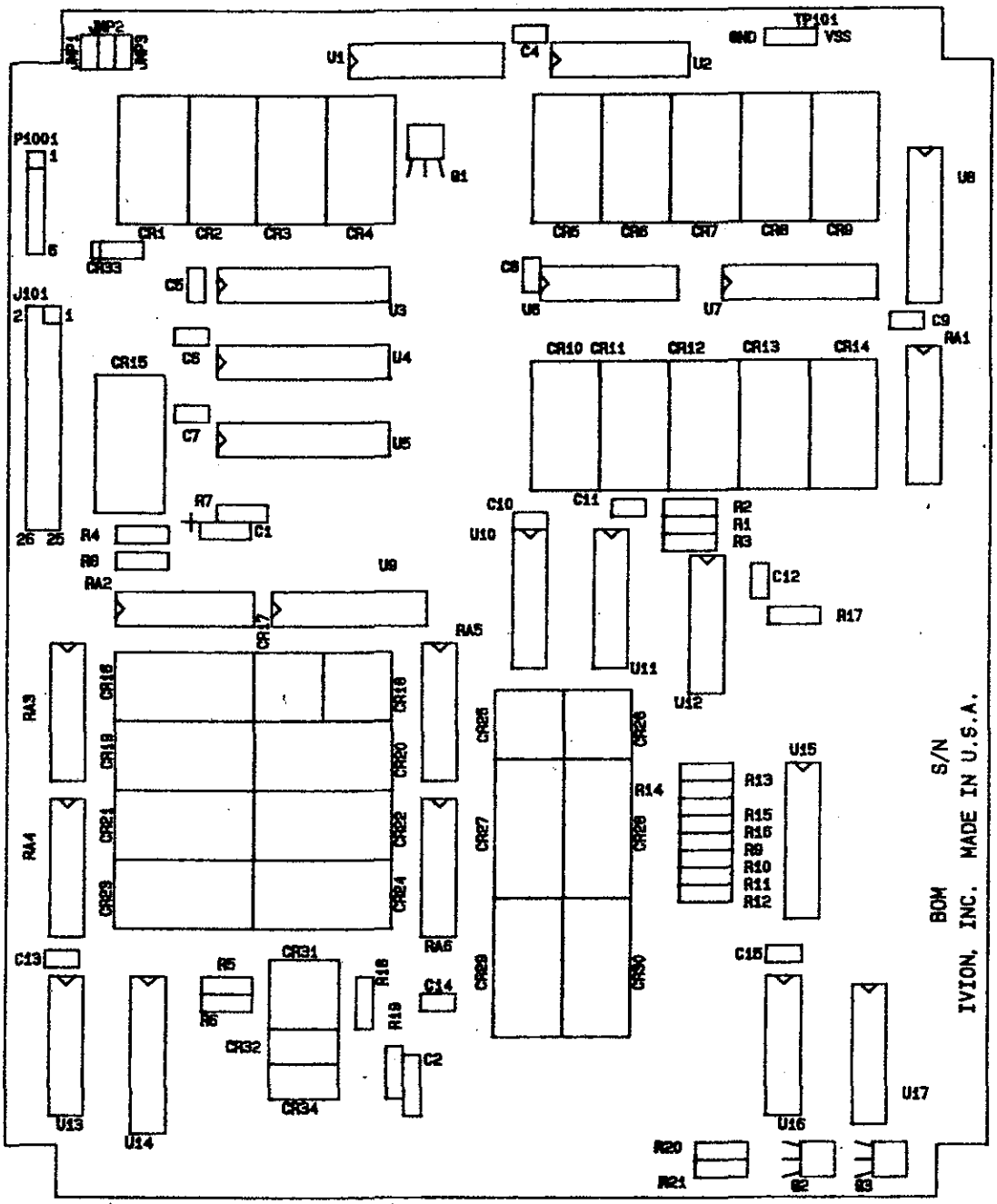


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Figure 16. Microprocessor Board Schematic

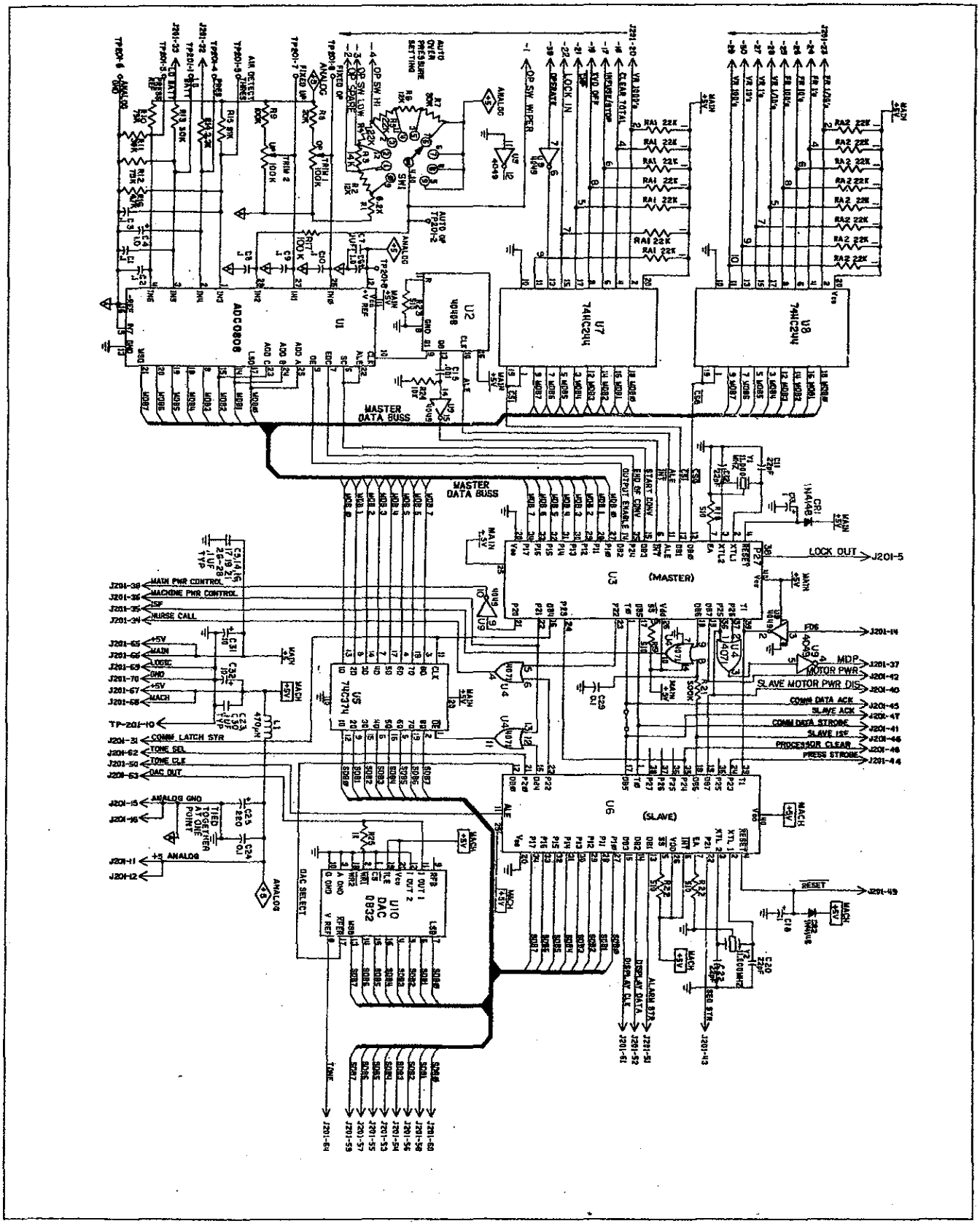
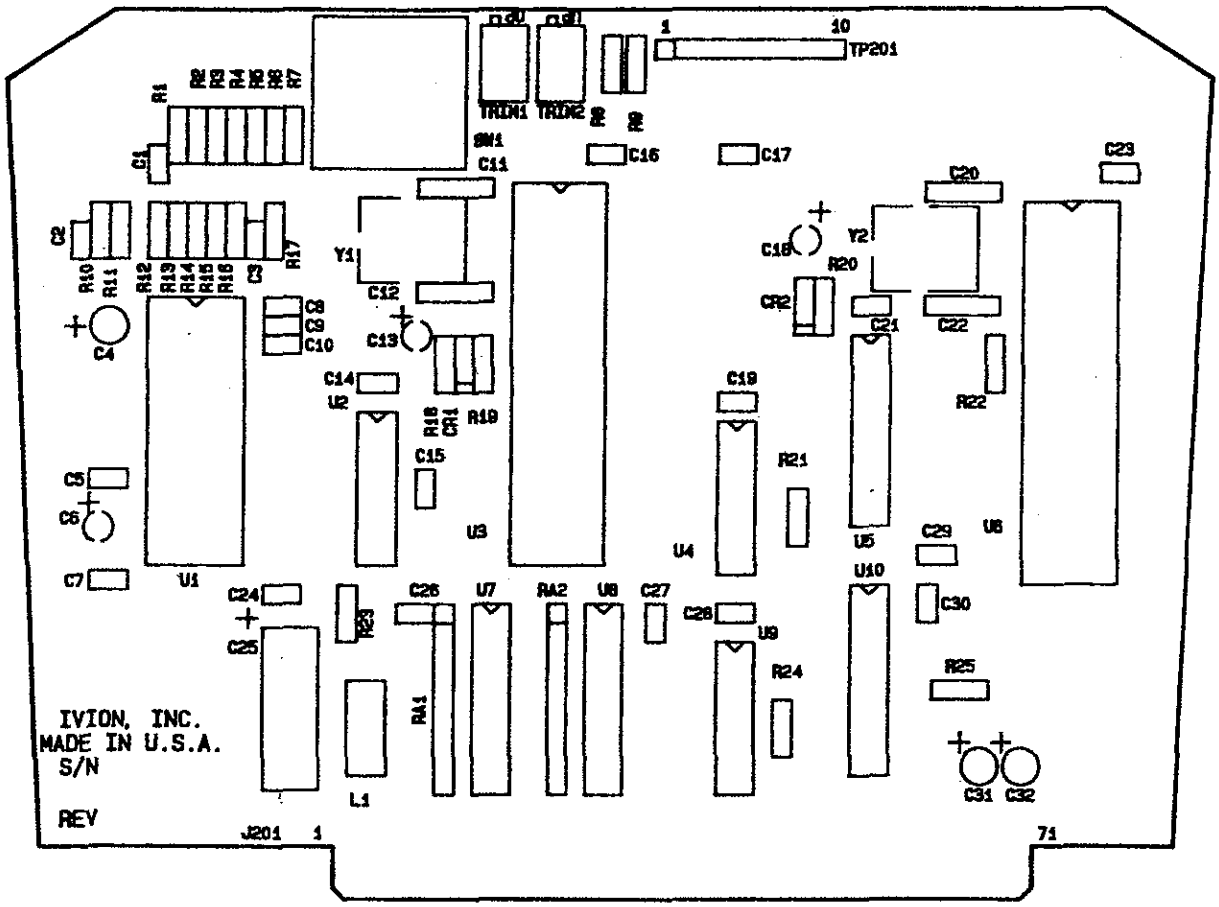


Figure 17. Microprocessor Board



Test Points On TP201

Number	Description
1	Low Battery Signal
2	Auto Overpressure Setting
3	Pressure Reference Voltage
4	Pressure Signal
5	Air Detect Threshold
6	Analog Ground
7	Fixed Underpressure Threshold
8	Analog +5 V
9	Fixed Overpressure Threshold
10	Ground

Figure 18. Power Management Board Schematic

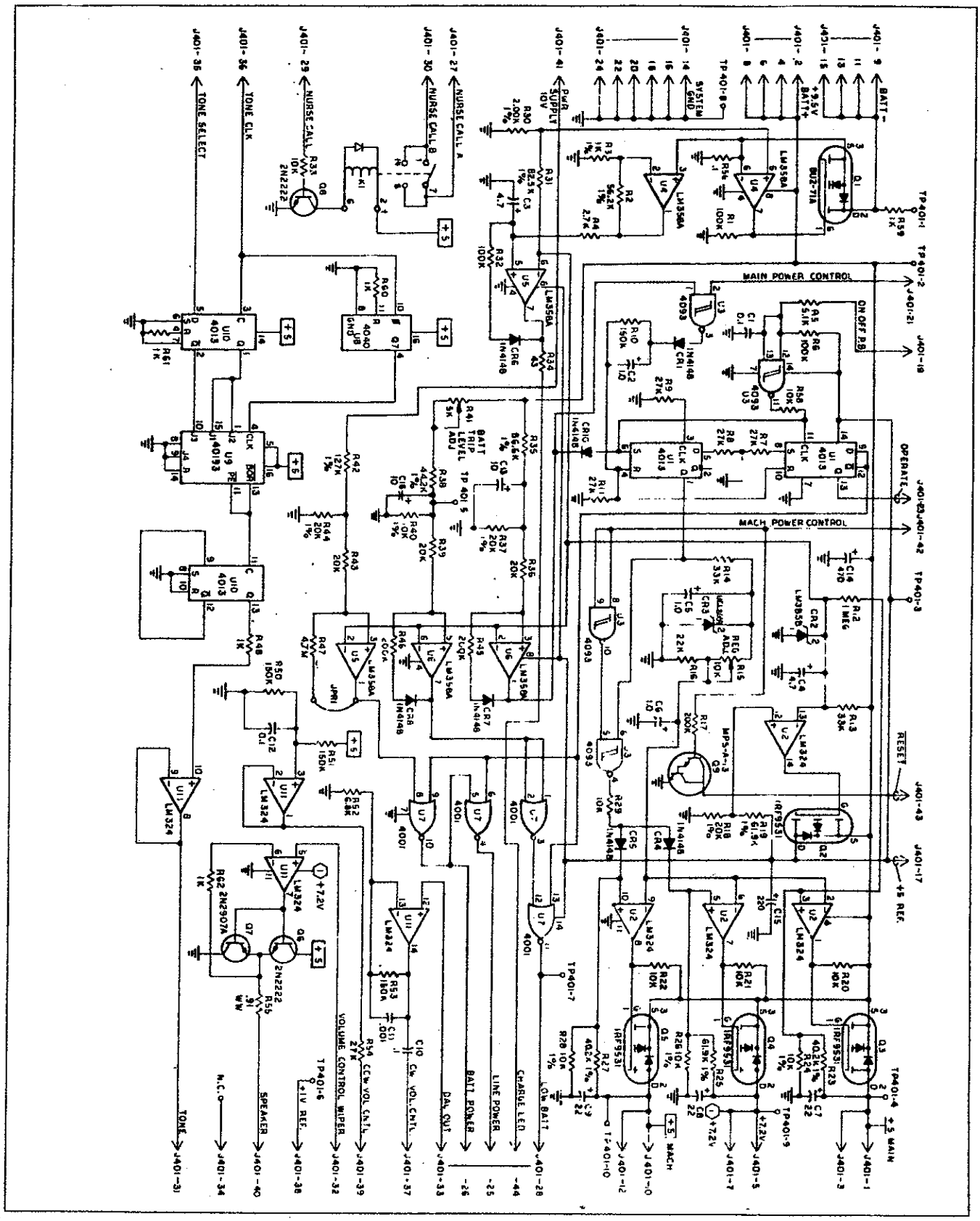
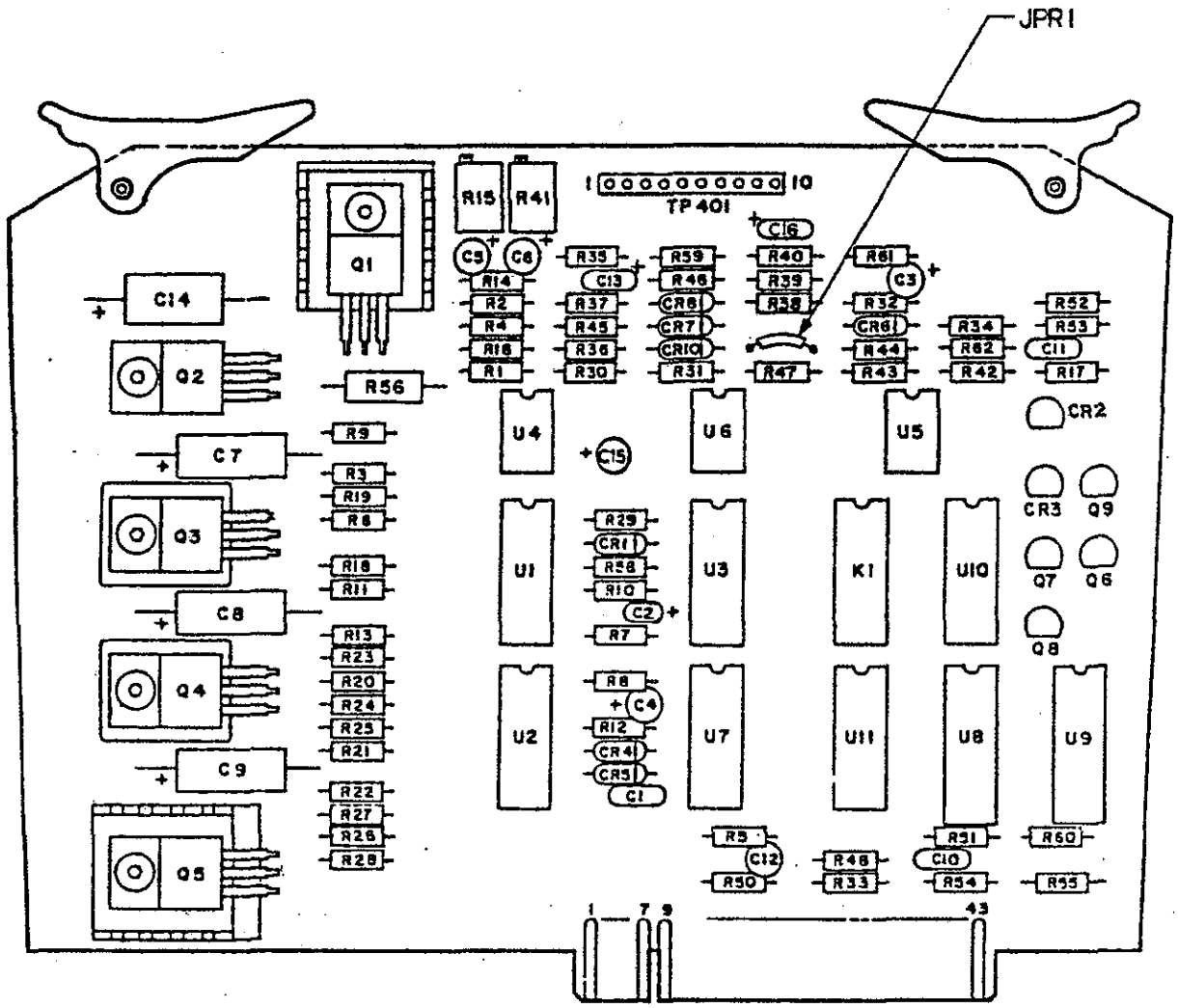


Figure 19. Power Management Board



TEST POINTS ON TP401

NUMBER	DESCRIPTION
1	Battery -
2	Battery +
3	+5 V Reference
4	+5 V Main
5	Low Battery Trip Level
6	+1 V Reference
7	Low Battery Signal
8	Ground
9	+7.2 V
10	+5 V Machine

Figure 20. Power Supply Board Schematic

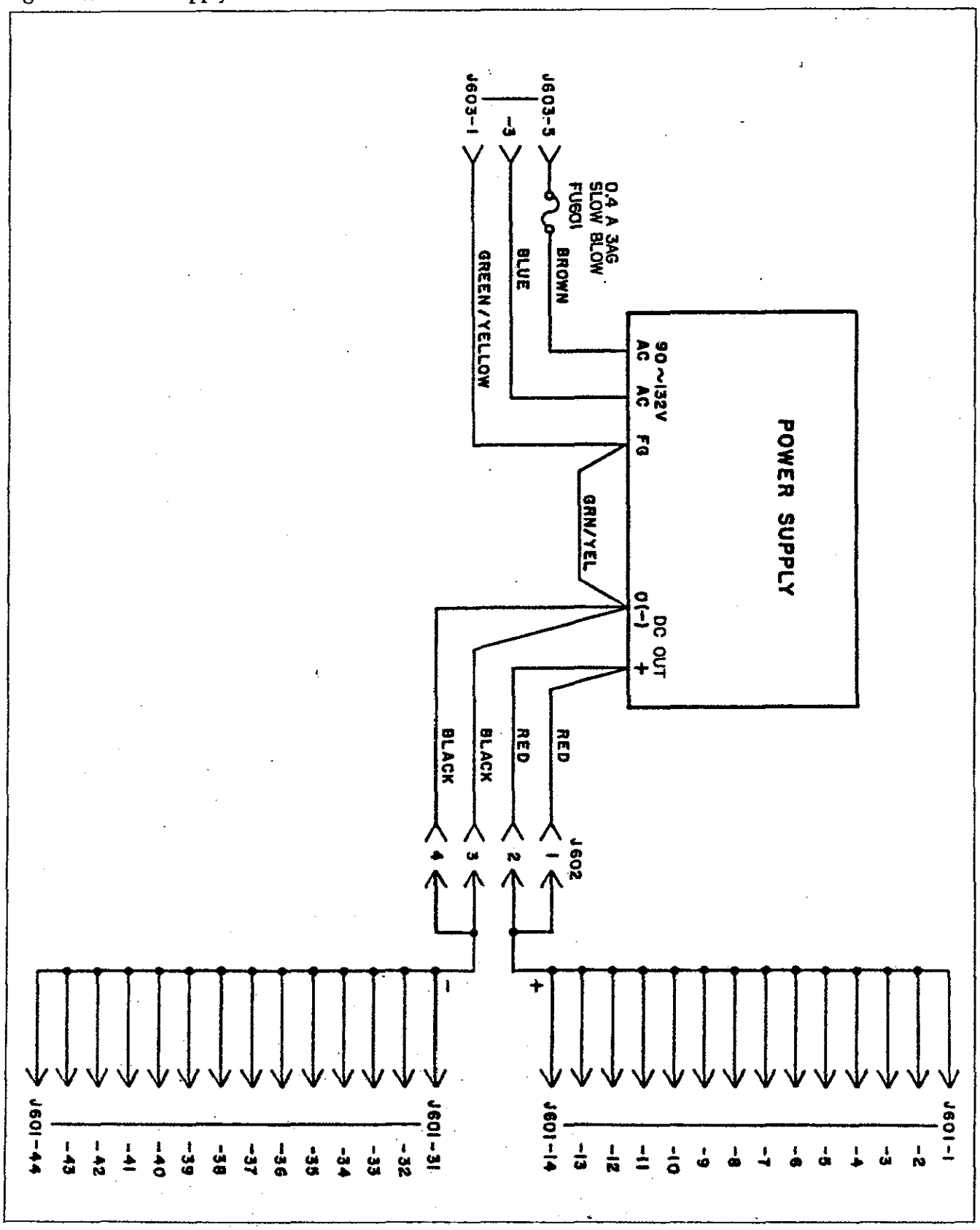


Figure 21. Power Supply Board

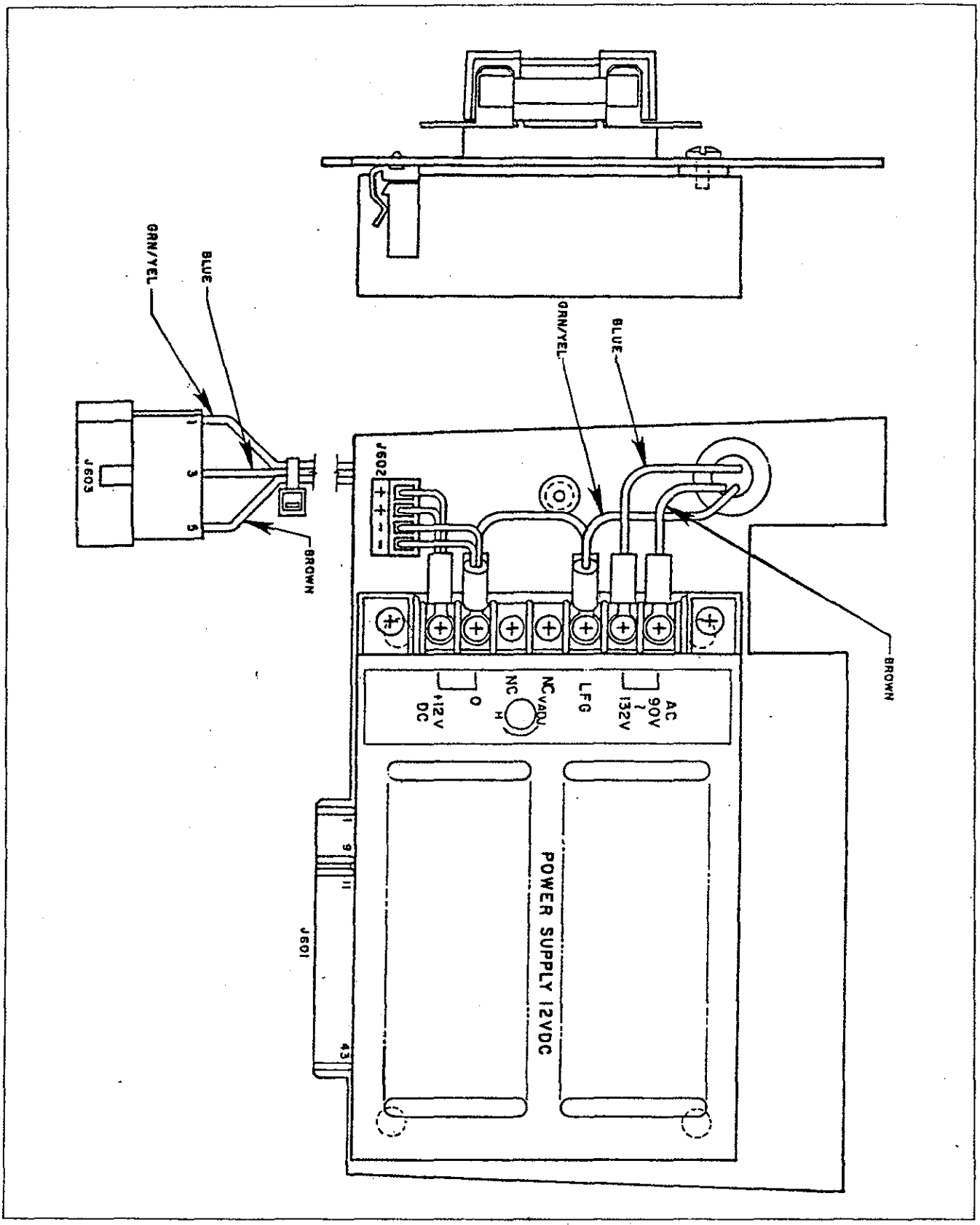


Figure 22. Opto-Sensor Board Schematic

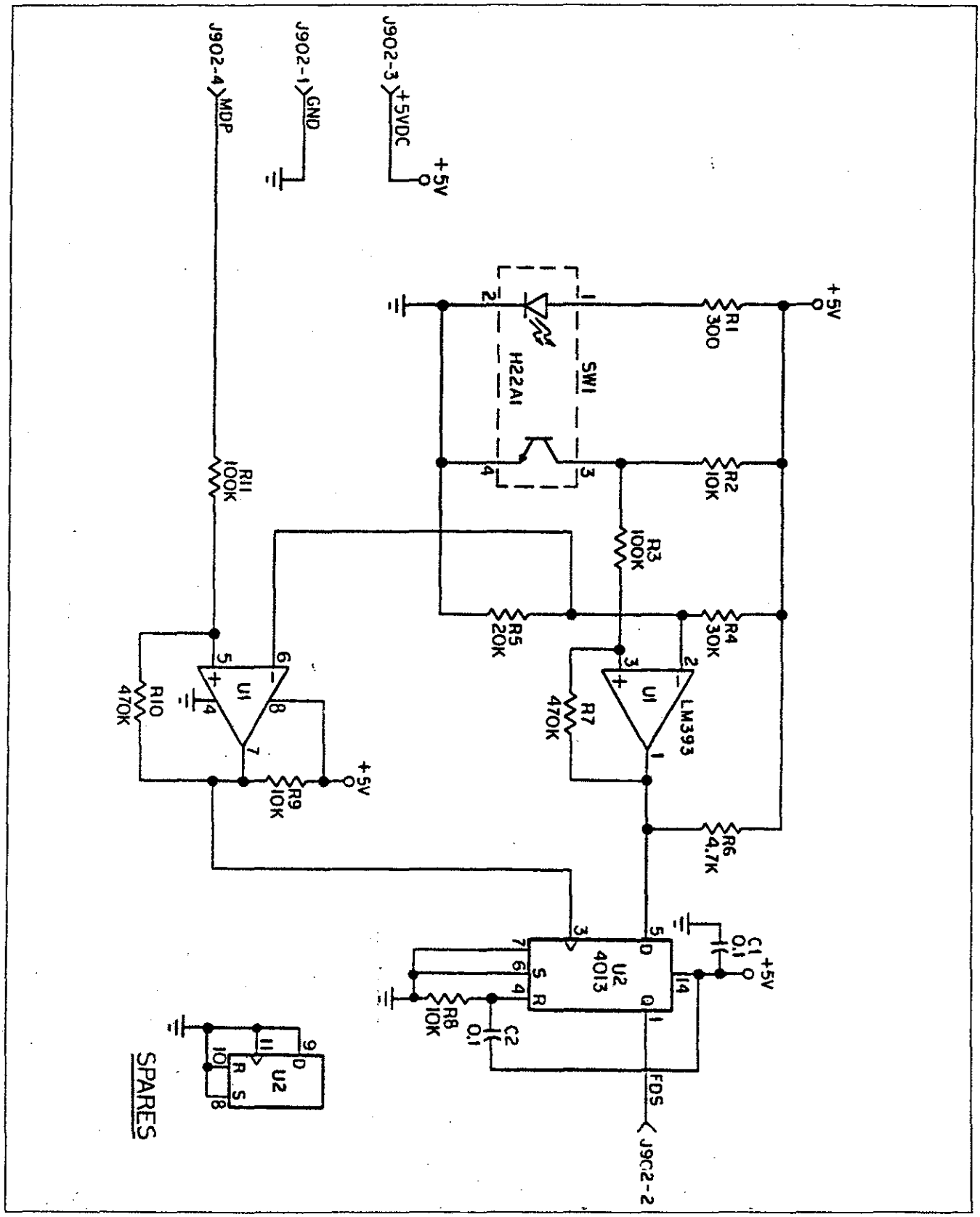


Figure 23. Opto-Sensor Board

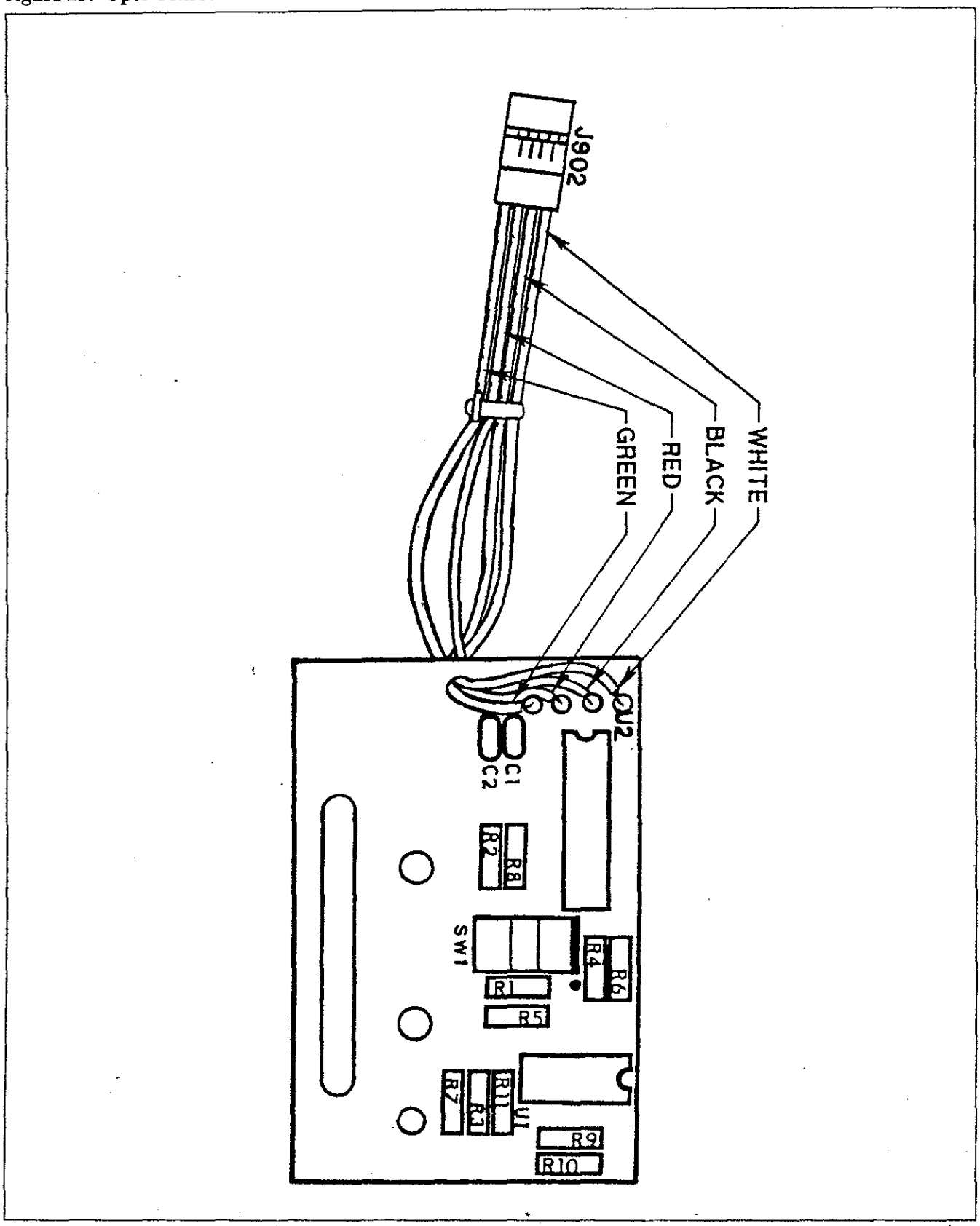


Figure 24. Pump Module Board Schematic

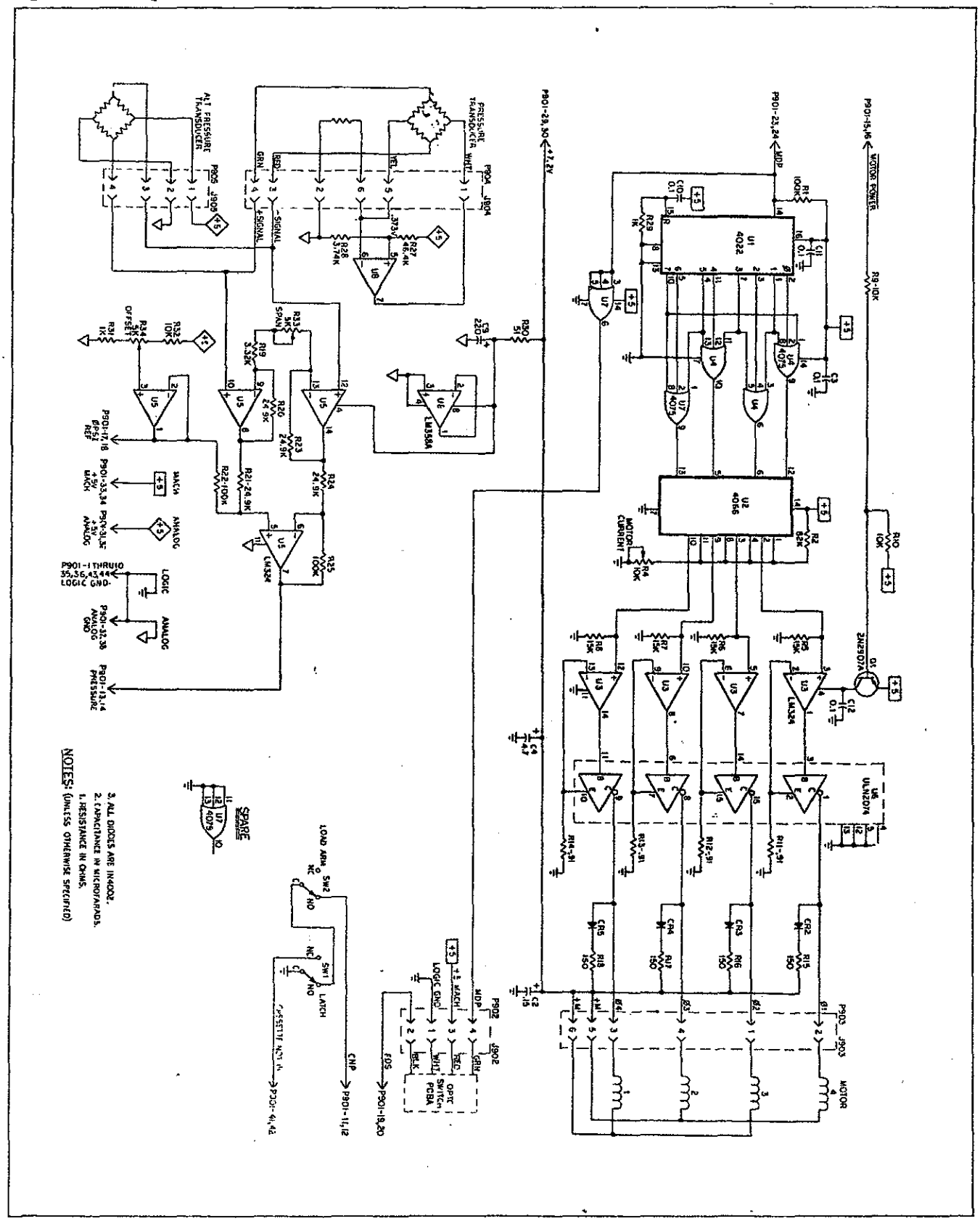


Figure 25. Pump Module Board

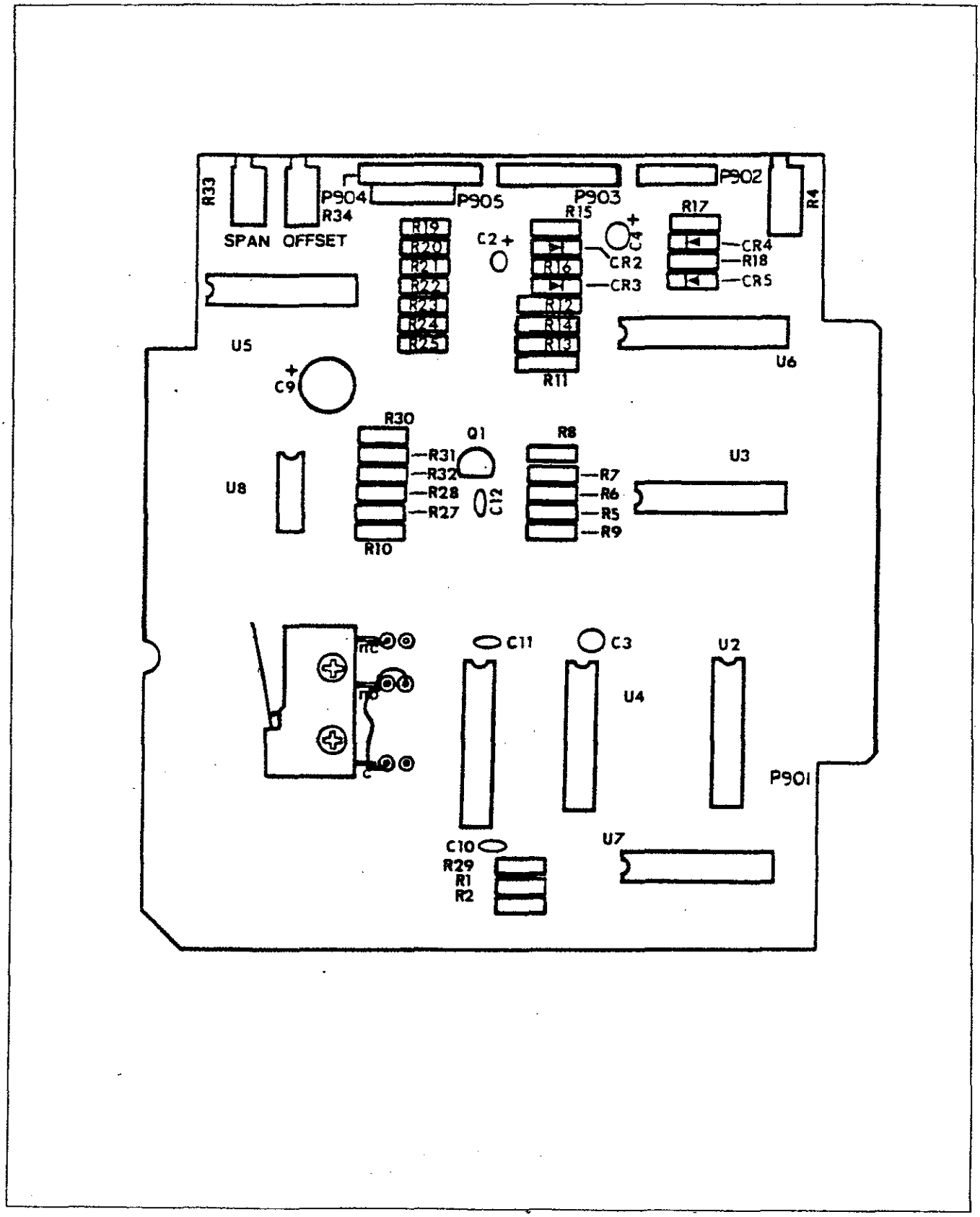


Figure 26. Parent Board Schematic

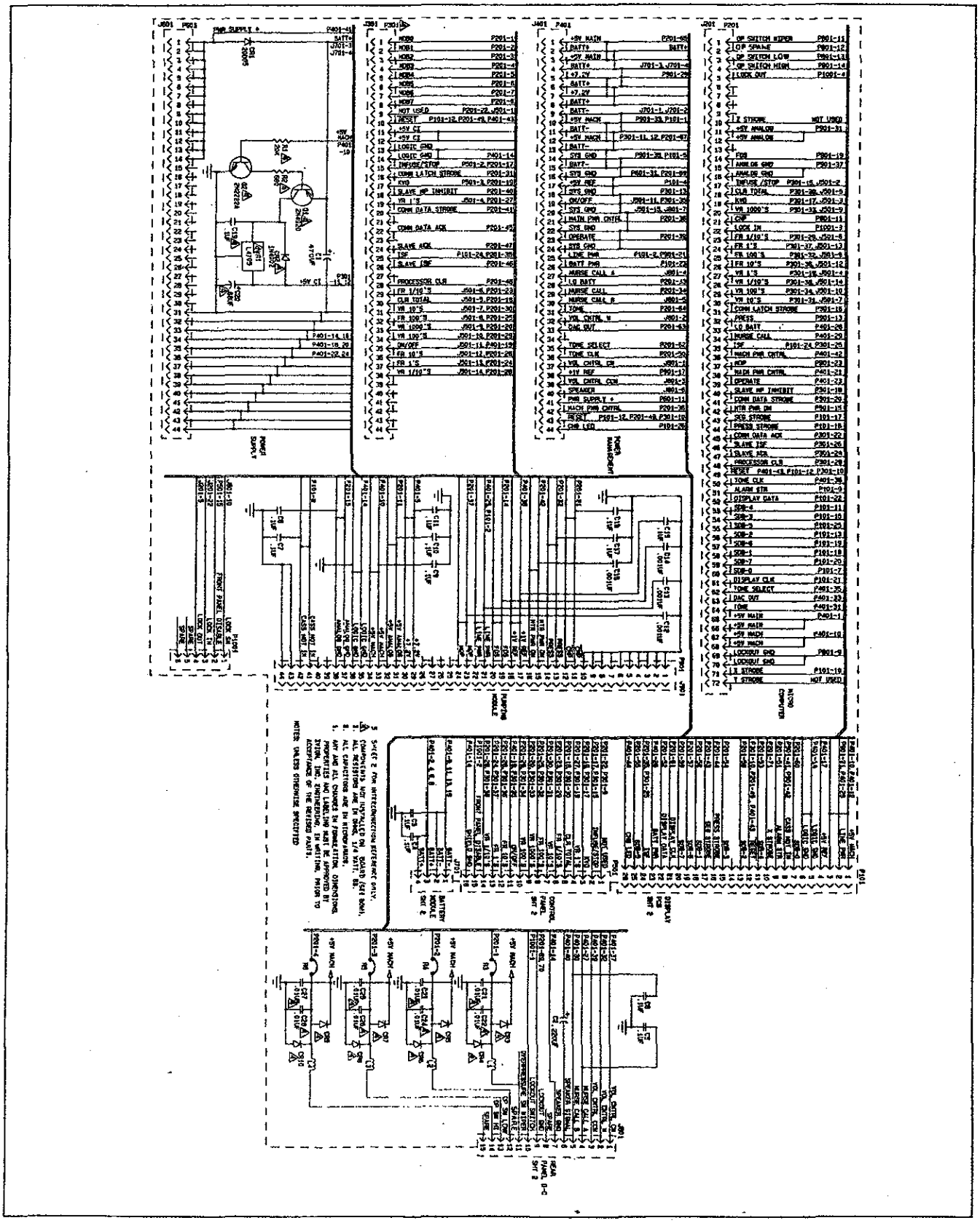


Figure 27. Parent Board

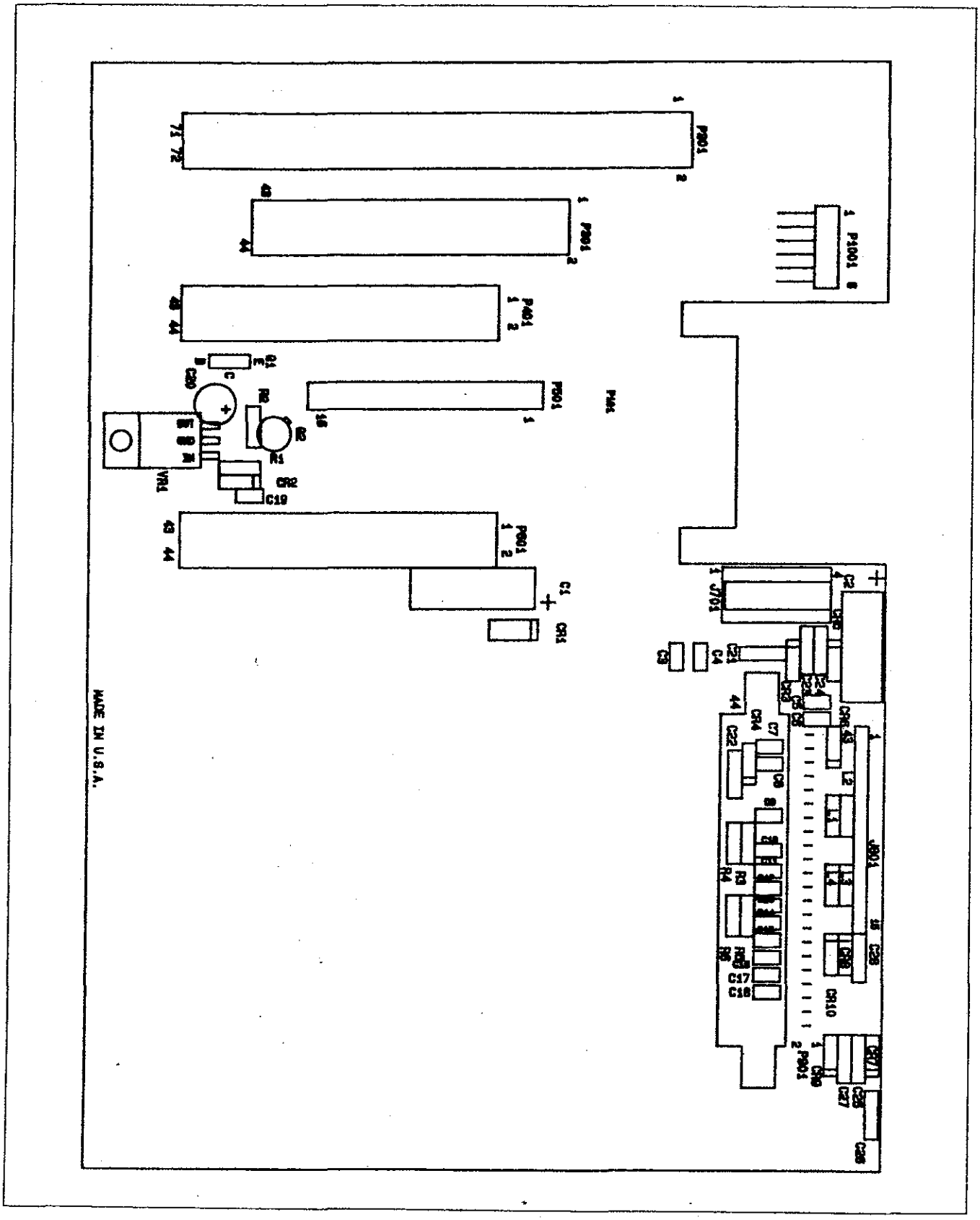
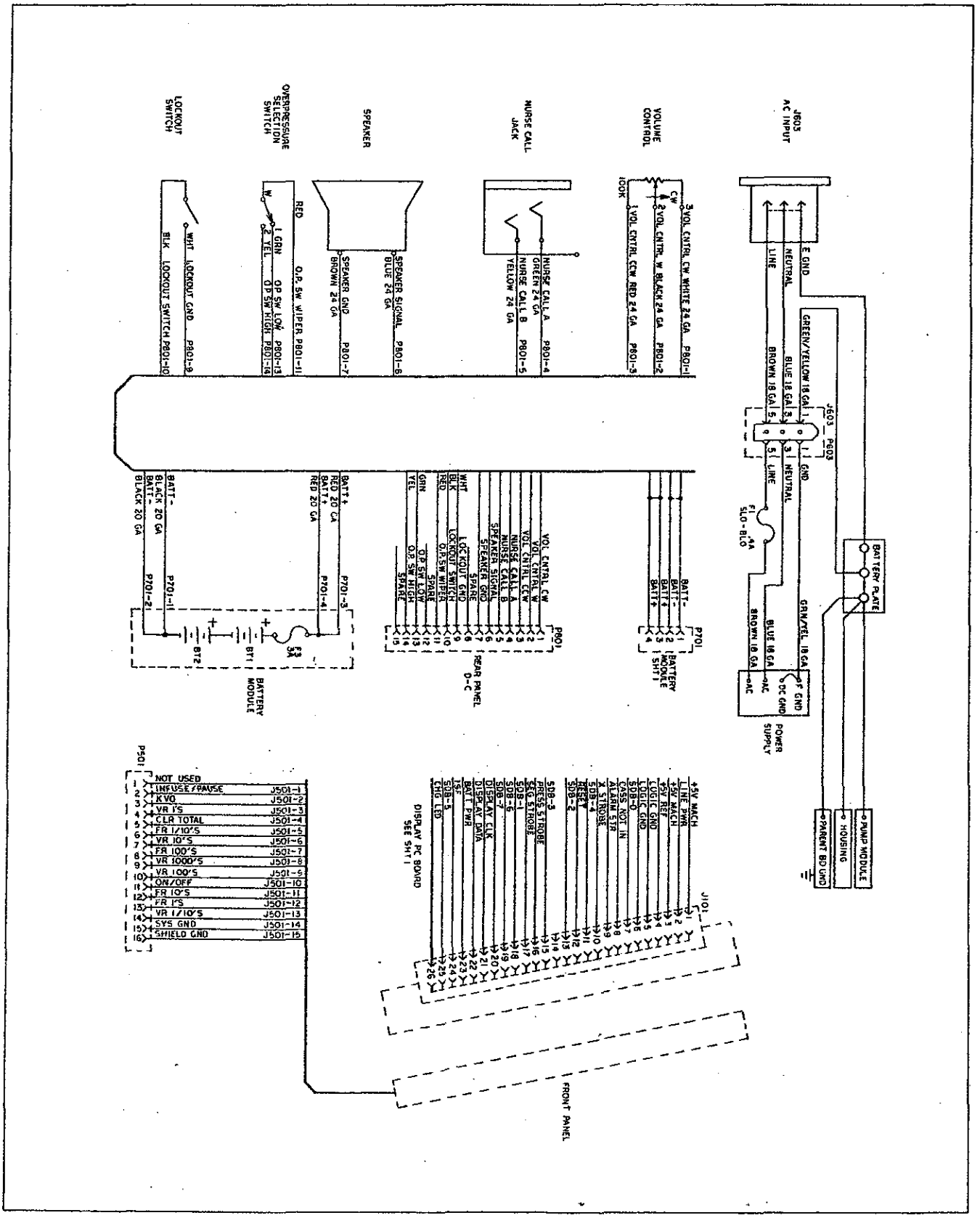


Figure 28. Internal Wiring Schematic



Section 8.0
Parts Lists

8.1

Major Subassemblies

DESCRIPTION	IVION PART NUMBER
AC Power Cord	207-500-049
Battery Pack Assembly	202-701-500
Control Panel (Front Panel)	202-701-504
Display Board	201-181-406
Parent Board	201-262-022
Microprocessor Board	201-182-403
Power Management Board	201-184-003
Power Supply Board	201-186-004
Pump Module	200-300-327

Instruction Lable " w- flow Clip Adapter G 104003
" w/o - flow Clip Adaptor G 216101344

BATTERY PACK ASSEMBLY **202-701-500**

DESCRIPTION	IVION PART NUMBER
Battery Cells-Set of 3	207-000-142
Fuse Holder	215-100-500
Mounting Plate	223-400-460

DISPLAY PANEL ASSEMBLY

DESCRIPTION	IVION PART NUMBER
Control Panel (Front Panel)	202-701-477
Display Board	201-181-406
Parent Board	201-262-022
Nut, Hex (4-40)	224-011-022
Nut, Hex (6-32)	224-011-042
Screw, Hex Head (4-40 x .812)	237-037-044
Screw, Hex Head (4-40 x 1.312)	237-037-051
Screw, Flat Head (4-40 x 1.375)	237-013-025
Spacer, Nylon (Display Board)	213-110-297
Spacer, Nylon (Parent Board)	213-110-291
Spacer, Nylon (Display Board Ctr.)	213-110-312
Spacer, Nylon (Top Interconnect)	213-110-320
Spacer, Nylon (Btm. Interconnect)	213-110-321

PUMP HOUSING ASSEMBLY

DESCRIPTION	IVION PART NUMBER
Cable Tie Retainer	213-130-021
Foot, Rear	213-400-047
Foot, Front	213-400-046
Guide Rail, Pump Module	223-100-423
Pole Clamp Jaw-Right	223-400-497
Pole Clamp Jaw-Left	223-400-498
Pole Clamp Knob	223-320-055
Pole Clamp Screw	223-400-343
Pole Clamp Screw Bushing-Left	213-110-466
Pole Clamp Screw Bushing-Right	213-110-465
Pole Clamp Screw Bushing-Center	213-110-186
Pole Clamp Screw "E" Clip	213-100-017
Pump Housing	202-701-338

REAR PANEL ASSEMBLY

DESCRIPTION	IVION PART NUMBER
AC Power Cord	207-500-049
AC Power Receptacle with Cable	202-400-328
AC Power Receptacle without Cable	208-300-007
Alert Volume Control	236-100-023
Alert Volume Control Knob	223-320-056
Battery Assembly	202-701-500
Battery Assembly Mounting Screws	237-037-036
Circuit Board Retaining Bracket	223-400-388
Nurse Call Jack	208-300-370
Speaker	241-003-001
Rear Panel	223-100-696
Rear Panel Hinge	213-160-003
Wiring Harness–Speaker, Volume Control, Nurse Call, OP and Lockout	202-400-892
Label OP and Lockout Switch	216-101-350
Lockout Switch	243-025-008
Pressure Switch	243-025-010

DISPLAY BOARD		201-181-406
REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Resistors		
R1,2,3	20, 5%, 1/4W	234-024-022
R4,19	100K, 5%, 1/4W	234-024-111
R5,6	180, 5%, 1/4W	234-024-045
R7	300K, 5%, 1/4W	234-024-122
R8	8.2, 5%, 1/4W	234-024-037
R9,10,11,12	8.2, 5%, 1/4W	234-024-013
R13, 14, 15, 16, 27	5%, 1/4W	234-024-025
RA1	RESISTOR NETWORK, 47 ohm	234-100-162
RA2,3,4,6	RESISTOR NETWORK, 180 ohm	234-100-161
RA5	RESISTOR NETWORK, 82 ohm	234-100-163
R18,20,21	20K, 5%, 1/4W	234-024-094
R17	160K, 5%, 1/4W	234-024-116
Capacitors		
C1	TANT 1µf, 20%, 35V	204-104-042
C2	CER MONO .01µf 50V	204-118-001
C4-15	CER MONO .1µf 50V	204-118-007
Integrated Circuits		
U8,15	I.C. UDN2585A	210-100-019
U3,4,5	I.C. 74C374	210-200-035
U1,7,9,14	I.C. ULN2803A	210-100-020
U2,6	I.C. 74C164	210-200-036
U13,18	I.C. 40194B	210-211-194
U11,12	I.C. 4024B	210-210-024
U17	I.C. 4027B	210-210-027
U10	I.C. 4078B	210-210-078
U16	I.C. 4093B	210-210-093

DISPLAY BOARD (cont)

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Diodes		
CR1-14	LED HP5082-7613	239-750-031
CR15,27,29	LED HLMP-2820	239-750-034
CR16,19, 21-24	LED HLMP-2685	239-750-024
CR17,18	LED HLMP-2755	239-750-033
CR20	LED HLMP-2785	239-750-032
CR25,31	LED HLMP-2800	239-750-036
CR26,28,30	LED HLMP-2720	239-750-035
CR32	LED HLMP-2400	239-750-056
CR34	LED HLMP-2300	239-750-055
CR26	LED HLMP-2700E	239-750-037
Transistors		
Q1	2N3906	239-100-024
Q2 & 3	2N2222A	239-100-011

MICROPROCESSOR BOARD		201-182-403
REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Resistors		
R18, 19, 20, 22, 23	510, 5%, 1/4W	234-024-056
R15	91K, 5%, 1/4W	234-024-110
R1	6.2K, 5%, 1/4W	234-024-082
R2, 6	12K, 5%, 1/4W	234-024-089
R7, 13	30K, 5%, 1/4W	234-024-098
R14	3.3K, 5%, 1/4W	234-024-075
R16	4.7K, 5%, 1/4W	234-024-079
R24	10K, 5%, 1/4W	234-024-087
R25	1K, 5%, 1/4W	234-024-063
R10, 12, 29	75K, 5%, 1/4W	234-024-108
R11	39K, 5%, 1/4W	234-024-101
TRIM1, 2	TRIMPOT 100K, #3299X	236-010-011
R21	300K, 5%, 1/4W	234-024-122
R4, 5	22K, 5%, 1/4W	234-024-095
R8	20K, 5%, 1/4W	234-024-094
R9, 17	100K, 5%, 1/4W	234-024-111
RA1, 2	RESISTOR NETWORK, 22K	234-100-102
R3	14K 1% 1/8W	234-201-399
Capacitors		
C11, 12, 20, 22	MICA 22pf, 5%, 500V	204-300-019
C4, 6, 13, 18	TANT 1µf, 20%, 35V	204-104-042
C15	MONO 1000pf, 10%, 100V	204-200-025
C31, 32	TANT 10µf, 20%, 25V	204-102-028
C1, 2, 3, 5, 7, 8, 9,	MONO .1µf, 20%, 50V	204-118-007
10, 14, 16, 17, 19,	MONO .1µf, 20%, 50V	204-118-007
21, 23, 24, 26-30	MONO .1µf, 20%, 50V	204-118-007
C25	ELECT 220µf, 16V	204-500-100

MICROPROCESSOR BOARD (cont)

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Integrated Circuits		
U3	MICROPROCESSOR - MASTER	210-730-082
U6	MICROPROCESSOR - SLAVE	210-730-083
U5	I.C. 74C374	210-200-035
U7, 8	I.C. 74HC244	210-200-034
U10	I.C. DAC 0832	210-750-002
U4	I.C. 4071B	210-210-071
U9	I.C. 4049B	210-210-049
U2	I.C. 4040B	210-210-040
U1	I.C. ADC0808	210-740-006
Diodes		
CR1, 2	1N4148	239-014-000
Miscellaneous		
L1	INDUCTOR, 470µH	251-100-038
Y1, 2	CRYSTAL, 11MHz	250-010-016

OPTO-SENSOR BOARD		*201-197-002*
REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Resistors		
R1	300, 5%, 1/4W	234-024-050
R2,8,9	10K, 5%, 1/4W	234-024-087
R3,11	100K, 5%, 1/4W	234-024-111
R4	30K, 5%, 1/4W	234-024-098
R5	20K, 5%, 1/4W	234-024-094
R6	4.7K, 5%, 1/4W	234-024-079
R7,10	470K, 5%, 1/4W	234-024-127
Capacitors		
C1, C2	MONO .1µf, 20%, 50V	204-118-007
Integrated Circuits		
U1	I.C. LM393	210-300-011
U2	I.C. 4013B	210-027-000
Miscellaneous		
OPT-1	OPTO-SENSOR	243-061-003

PARENT BOARD		201-262-022
REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Capacitors		
C1	470µf	204-500-015
C2	ELECT 220µf	204-500-100
C3-11,15, 17,18	MONO .1µf, 20%, 50V	204-118-007
C12-14,16	CAP 1000PF, 100V, 15%	204-200-025
Diodes		
CR1	DIODE, 2 amp, 50V	239-500-011
Connectors		
P201	72 CONTACT	208-300-368
P401,601	44 CONTACT	208-300-365
P501	RT ANGLE, 16 PIN	208-199-066
P901	90 DEG, 44 CONTACT	208-300-360
P1001	RT ANGLE, 6 PIN	208-199-056
J701	4 PIN	208-160-054
J801	CONN 15 PIN	208-188-015
Inductors		
L1-4	Ferrite Bead	251-100-090

POWER MANAGEMENT BOARD 201-184-003

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
R1,6,32	100K, 5%, 1/4W	234-024-111
R2	56.2K, 1%, 1/8W	234-201-457
R3	1K, 1%, 1/8W	234-201-289
R4	2.7K, 5%, 1/4W	234-024-073
R5	5.1K, 5%, 1/4W	234-024-080
R7,8,9,11,54	27K, 5%, 1/4W	234-024-097
R10,50,51,53	150K, 5%, 1/4W	234-024-115
R12	1MEG, 5%, 1/4W	234-024-135
R13,14	33K, 5%, 1/4W	234-024-099
R15	TRIMPOT 10K, #3299X	236-010-007
R16	22K, 5%, 1/4W	234-024-095
R17,45,46	200K, 5%, 1/4W	234-024-118
R18,37,44	20K, 1%, 1/8W	234-201-414
R19,25	61.9K, 1%, 1/8W	234-201-461
R23,27	40.2K, 1%, 1/8W	234-201-443
R24,26,28,40	10K, 1%, 1/8W	234-201-385
R29,33,58,20,21,22	10K, 5%, 1/4W	234-024-087
R30	2K, 1%, 1/8W	234-201-318
R31	82.5K, 1%, 1/8W	234-201-473
R34	43, 5%, 1/4W	234-024-030
R35	86.6K, 1%, 1/8W	234-201-475
R36,39,43	20K, 5%, 1/4W	234-024-094
R38	44.2K, 1%, 1/8W	234-201-447
R41	TRIMPOT, 5K, #3299X	236-010-006
R42	127K, 1%, 1/8W	234-201-491
R48,59-62	1K, 5%, 1/4W	234-024-063
R52	6.8K, 5%, 1/4W	234-024-083
R47	4.7M, 5%, 1/4W	234-024-150
R55	WIREWOUND .91, 5%, 1/2W	234-034-001
R56	POWER .1, 1%, 3w	234-028-001

Capacitors

C1,10,12	MONO .1µf, 20%, 50V	204-118-007
C2,5,6	TANT 1µf, 20%, 35V	204-104-042
C3,4	TANT 4.7µf, 10%, 35V	204-104-009
C14	ELECT 470µf, 16V	204-500-015
C11	MONO 1000pf, 10%, 100V	204-200-025
C13,16	TANT 10µf, 25V	204-102-028
C15	ELECT 220µf, 10V	204-500-021
C7,8,9	TANT 22µf, 35V	204-600-022

POWER MANAGEMENT BOARD (cont.)

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Integrated Circuits		
U1,10	I.C. 4013B	210-027-000
U2,11	I.C. LM324N	210-022-000
U3	I.C. 4093B	210-250-094
U4,5,6	I.C. LM358AN	210-300-013
U7	I.C. 4001B	210-210-001
U8	I.C. 4040B	210-210-040
U9	I.C. 40193B	210-211-193
Diodes		
CR1,4-8,10	1N4148	239-014-000
CR2	VOLT REG 1.235V, 1%	210-300-076
CR3	REGULATOR, 1.23V ICL8069D	210-300-070
Transistors		
Q1	FET BUZ71A	239-200-006
Q2-5	FET IRF9531	239-200-004
Q6,8	2N2222A	239-100-001
Q7	2N2907A	239-100-012
Q9	MPS-A13	239-100-020
Relays		
K1	REED SPST w/diode 5V	230-006-001

POWER SUPPLY BOARD **201-186-004**

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
FU601	FUSE 0.4A 3AG slow blow	215-005-055
	Power Supply Module	202-701-406

PUMP MODULE BOARD **201-264-002**

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Resistors		
R1	100K, 5%, 1/4W	234-024-111
R2	82K, 5%, 1/4W	234-024-109
R4	TRIMPOT 10K, #3299X	236-010-007
R5,6,7,8	15K, 5%, 1/4W	234-024-091
R9,10,32	10K, 5%, 1/4W	234-024-087
R11,12,13,14	WIREWOUND .91, 5%, 1/2W	234-034-001
R15,16,17,18	150, 5%, 1/4W	234-024-043
R20,21,23,24	24.9K, 1%, 1/4W	234-201-423
R22,25	100K, 1%, 1/8W	234-201-481
R27	46.4K, 1%, 1/8W	234-201-449
R28	3.74K, 1%, 1/8W	234-201-344
R29,31	1K, 5%, 1/4W	234-024-063
R30	51, 5%, 1/4W	234-024-032
R33,34	TRIMPOT, 5K, #3299X	236-010-006
Capacitors		
C2	TANT .15µf, 10%, 35V	204-104-032
C4	TANT 4.7µf, 10%, 35V	204-104-009
C9	ELECT 220µf, 10V	204-500-201
C3,10,11,12	MONO 0.1µf, 20%, 50V	204-118-007
Integrated Circuits		
U1	I.C. 4022B	210-211-022
U2	I.C. 4066	210-200-022
U3,5	I.C. LM324N	210-022-000
U4,7	I.C. CD4075B	210-210-075
U6	I.C. ULN2074B	210-100-014
U8	I.C. LM358A	210-300-013
Diodes		
CR2,3,4,5	1N4002	239-091-002

PUMP MODULE BOARD (cont.)

REFERENCE DESIGNATOR	DESCRIPTION	IVION PART NUMBER
Transistors		
Q1	2N2907A	239-016-000
Microswitches		
SW1	SUBMIN SPDT	243-025-001

PUMP MODULE	**200-300-315**

DESCRIPTION	IVION PART NUMBER
CAM	223-100-582
CAM FOLLOWER	207-000-132
OPTO-SENSOR BOARD	201-197-002
PUMP MODULE BOARD	201-264-002
MOTOR	220-005-010
RECEPTACLE ASSEMBLY	202-701-480
VANE	223-400-377
TRANSDUCER CABLE	202-400-250
OPTO-SENSOR BRACKET	223-301-112

8.2

Service Tools

DESCRIPTION	IVION PART NUMBER
Extender Board, Microprocessor	201-182-102
Extender Board, Pump Module	201-189-010
Extender Board, Pwr Management/Pwr Supply	201-184-102
Transducer Simulator	201-268-000
Calibration Board	IVSK09